CITY OF SCOTTSDALE

Drainage Reports

Drainage Report

Deer Valley Townhomes

NWC Miller Rd & Deer Valley

City of Scottsdale

Maricopa County, Arizona

TSC Project No. 0800

February 18, 2020

Prepared for:

Beardsley 22, Inc.

222 W Linger Lane

Phoenix, AZ 85021

Plan #
Case # 43-DR-2019
Q-S #
☒ Accepted
☐ Corrections
N.Baronas 4/6/2020
Reviewed By Date

Registered Professional Engineer (Civil)
CERTIFICATE NO.
41715
LISA
NELSON
02/18/19
Date Signed
ARIZONA U.S.A.

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1.0 Introduction

1.1 Report Purpose

The purpose of this drainage report is to provide hydrologic and hydraulic documentation for the proposed Deer Valley Townhomes site. More specifically, a design review of surface grading, retention with bleed off and offsite flow that impacts the site. The project will be designed and developed in accordance with the City of Scottsdale and Maricopa County's current development standards and client requirements.

1.2 Site Description

The proposed Deer Valley Townhomes development (Project) consists of attached townhomes split between three (3) buildings on an one acre parcel. The Site is defined by the parcel boundary for APN# 212-02-010E and is located at the northwest corner of Miller Road and Deer Valley Road in Scottsdale (see figure 1 below). The current project zoning is PCOC and proposed project zoning is R-3. The majority of the Site is undeveloped. A regional drainage channel exists along the east property boundary in approximately a 50' wide drainage channel. The proposed development will be constructed all at once and will not be phased.

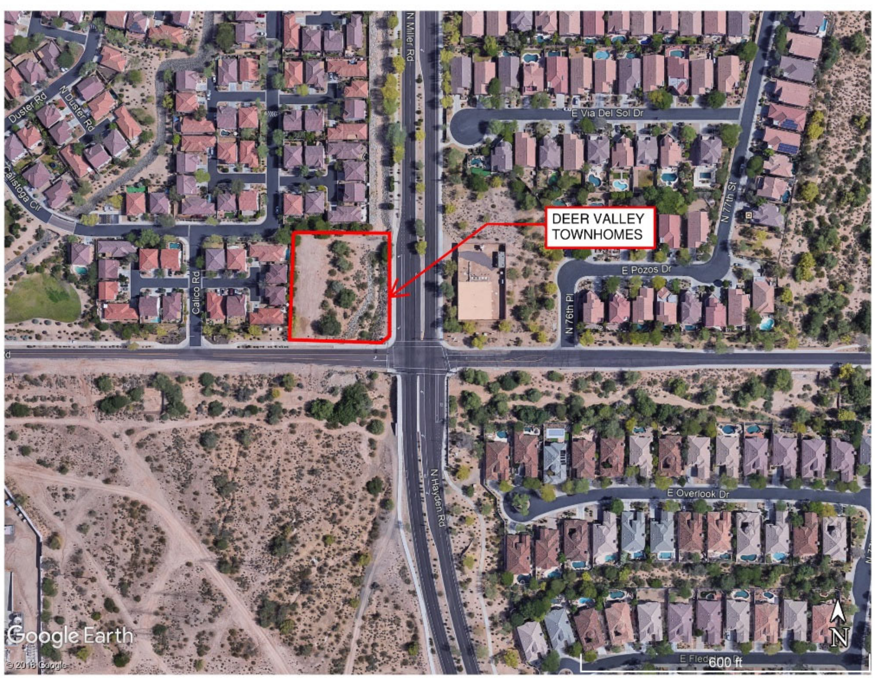

Figure 1: Location Map

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1.3 Watershed Description

The existing land use in the watershed is mainly single family residential with a commercial/office/retail generally at the major corners. The project is located in the northeast corner of the Lower Rawhide Wash watershed identified in the Pinnacle Peak West ADMS. For reference, there are figures from the ADMS in **Appendix D**. The Site has a smaller sub-watershed that contributes to the channel on site. In general, the watershed slopes from the northeast to the southwest and extends up to the neighborhoods along Hayden Road just north of Pinnacle Peak Road. There are two areas that are channelized and combine into one channel and pass under Miller Road. The channel continues south on the west side of Miller Road and flows into a box culvert at the northeast corner of our Site. Flows continue south, along on the east side of the parcel within a public drainage easement, and enter a box culvert under Deer Valley Road. The stormwater empties into the Grayhawk channel that flows from east to west on the south side of Deer Valley Road.

1.4 On-Site Topographic Conditions

The existing ground generally slopes from northeast to southwest at approximately 2%. Exhibits provided in **Appendix B** present the existing topographic conditions for the Project. Both Miller Road and Deer Valley Road are fully improved and catch basin with grate and curb inlet exists in the north curb line of Deer Valley.

1.5 FEMA Flood Insurance Map

The project is entirely located within Zone "X" according to Flood Insurance Rate Map (FIRM) Panel 04013C1320L which is effective October 16, 2013 (REF 1). Zone X is defined as: 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile. (Please refer to FIRMETTE in **Appendix A**).

2.0 <u>Technical Analysis</u>

2.1 FLO-2D

The Pinnacle Peak West ADMS (PPW ADMS) contains a 2016 FLO-2D analysis that was completed for the Rawhide Wash Alternatives Refinement. JE Fuller is currently under contract with FCDMC for the Rawhide Wash Flood Hazard Mitigation Final Design. A Memorandum provided by JE Fuller indicates that a revised and more accurate FLO-2D model has been developed that covers this project Site (PPW FLO-2D Model). Refer to **Appendix D** for JE Fuller Memorandum. Terrascape accepts the results of the FLO-2D model. According to the JE Fuller Memorandum, the discharge for the drainage channel within the Site was estimated using the existing conditions and by adding the peak discharges though the existing 4-8x4 arch culverts. As a result, the combined discharge from the outlet of culverts is 373 cfs, which is considered conservative. A 1.3 safety factor was applied to the peak discharge, increasing the design discharge to 485 cfs. The design peak discharge rate is lower than 750 cfs, therefore no Vista Corridor easement will be required.

2.2 HEC-RAS

The 100-year, 24-hour flow rate obtained from the FLO-2D Model, including a factor of safety, and used in the HEC-RAS model created for the channel. The purpose of the model was to determine the water surface elevations (WSE) in the channel in order to set the lowest finished floor elevations for the residential structures. The WSE are shown on the Grading and Drainage Plan found in **Appendix B**. Output from the model, including the boundary conditions per each cross-section, is found in **Appendix E**. Model results show that the regional flows are contained within the channel and within the Site and Deer Valley Road box culverts.

2.3 Stormwater Storage Facilities

The Site is being developed on a parcel that was excluded from the Arizona Silverado subdivision. The subdivision developer and the City originally envisioned this Site to be a commercial development. Evidence of this can be seen by previous submittals made to the City by other developers, and are cited in the reference section. The significance of this project history relates to stormwater storage. This parcel was not conceptually planned with the intent to provide regional stormwater conveyance and on-site stormwater storage design. There is not enough surface area to provide stormwater detention basins and therefore stormwater detention facilities with a bleed-off pipe is not feasible. Upon development of this Project, any runoff that exceeds the capacity of the storage facility would occur and pass prior to regional peak. This is due to a Site time of concentration of 5 or 10 min, versus a regional watershed time of concentration of 13.4 hours (Refer to Channel Hydrograph in **Appendix C**).

The drainage channel along the eastern portion of the property consumes approximately 30% of the Parcel. This is a significant impediment to the property and supports the request for a Stormwater Storage Waiver located in **Appendix D**. The FLO-2D and the HEC-RAS analyses show that there is sufficient capacity in the channel to handle post-development flows from this Site. The application form for the waiver states the following condition:

> "The development is adjacent to a conveyance facility that an engineering analysis shows is designed and constructed to handle the additional runoff from the site as a result of development."

Based on first flush design standard for computing retention volume, underground storage is proposed for this Project. The first flush volume calculation based on the Site's net area is based on Section 4-1.201 in the Design Standards & Policies Manual and provided in **Appendix C**.

2.4 Lowest Finished Floor Verification

All finished floors elevations have been set based on the water surface elevations in the channel at the upstream building corner. The Grading & Drainage Plan contains this information and the set is found in **Appendix B**. The northern 5-pack of townhouses is 3.58' above the WSE on the inlet side of the on-site culvert. The southern 2-pack of townhouses along the channel is 2.17' higher than the WSE at the cross section on the outlet side of the on-site culvert.

The lowest elevation within the developed area is at a storm drain inlet within the trash turning maneuver area at the southwest corner. The elevation of the inlet is 75.50. If clogging or overflow occurs, the overtopping elevation is 76.00 for the top of curb adjacent to the inlet and on the east side of the driveway. Two locations are provided for ultimate outfalls; one at the southwest corner of the Site at elevation 75.0 and one into the channel at 74.90. Both locations route to the Greyhawk channel on the south side of Deer Valley Road.

2.5 Riprap Revetment Analysis and Erosion Protection

Two (2) field investigations were performed in order to determine the existing rip rap depth in the channel. A geotechnical engineer, Smith & Annala Engineering (SAECO), performed mechanical field excavations to determine depth and rip rap size. After review of the data provided by SAECO, the drainage engineer with JE Fuller (JEF) reviewed historical aerial photography and discovered that the channel was originally built with rip rap lining. JEF performed hand excavations and determined that the original channel lining exists under the silt in the flowline. Refer to **Appendix D** for Memorandums provided by JE Fuller and SAECO.

The field investigation from JE Fuller shows that both the side slopes and bottom of the existing channel are currently lined with riprap, however, sediment has accumulated in the channel bottom covering the riprap. Channel as-built plans were not found during a research conducted by Terrascape. The investigation result from JE Fuller indicates that the thickness of the riprap layer

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is approximately 16" to 20" with a d_{50} of about 20" and filter fabric underlayment. The investigation result from SAECO also confirms that the riprap size is approximately 14" to 20" in thickness.

In order to confirm that the existing riprap is sufficient to meet current standards for erosion protection, riprap sizing calculations have been performed by JE Fuller and is attached in **Appendix D**. The riprap size analysis equation was used from FCDMC Hydraulics Manual, with the current 100-year designed peak discharge rate. The calculated minimum riprap size is d_{50} = 10.5" and the minimum thickness is 16". Since the existing riprap layer thickness is at least 16", the channel lining is considered sufficient to protect channel from bed and lateral erosion. Please refer to **Appendix D** for riprap sizing calculations and scour analysis provided by JE Fuller.

3.0 Report Conclusions

The following conclusions have been reached as a result of this drainage investigation, in support of the proposed Deer Valley Townhomes Project:

- This drainage report was prepared in accordance with the recommendations and design parameters from the *Design Standards & Policies Manual* (REF 2), and MCFCD *Drainage Design Manuals, Volume I and II* (REF 4&5).
- The required retention volume is provided and based on first flush volume calculation. On-site sub-surface retention is provided with soil percolation and is designed to drain within 36 hours. A waiver for stormwater storage is included within this report package.
- Building lowest finished floor elevations for the Project exceed a minimum of 12-inches above the 100-year 24-hour water surface elevations in the adjacent channel.
- A Request for Stormwater Storage Waiver has been submitted to request required detention volume to be based on first flush.

4.0 References

1. Flood Insurance Rate Map, Maricopa County, Arizona, Map Number 04013C1320L, Federal Emergency Management Agency, Washington DC, October 16, 2013.
2. Design Standards & Policies Manual, City of Scottsdale, AZ, 2018.
3. MAG Uniform Standard Details for Public Works Construction, Maricopa Association of Governments, Phoenix, AZ, 2015 Revision.
4. Drainage Design Manual for Maricopa County, Arizona – Hydrology, 4th Edition, Flood Control District of Maricopa County, Phoenix, AZ, August 15, 2013.
5. Drainage Design Manual for Maricopa County, Arizona – Hydraulics, 3rd Edition, Flood Control District of Maricopa County, Phoenix, AZ, August 15, 2013.
6. Watercourse System Sediment Balance, State Standard Attachment 5-96, Arizona Department of Water Resources, September 1996.
7. Preliminary Drainage Plan, Hook Engineering, Inc., Phoenix, AZ, May 9, 1997.
8. Pinnacle Peak West Area Drainage Master Study: Draft Hydrology & Hydraulics Report, Volumes 1&2, Flood Control District of Maricopa County Project No. F0701, TYLIN International, July 26, 2013.
9. Pinnacle Peak West Area Drainage Master Study: Rawhide Wash Alternatives Refinement, Flood Control District of Maricopa County, JE Fuller Hydrology & Geomorphology, Inc., June 2016.
10. Final Plat for Arizona Silverado, CMX Group, Inc., November 7, 1997.
11. Conceptual Grading & Drainage Plan for Convenience Store/Bank, CMX Group, Inc., September 4, 1998.
12. Grayhawk Deer Valley Channel, Phase 1, Gilbertson Associates, Inc., March 31, 1995.
13. Preliminary Drainage Report for Commercial Site Development, Hook Engineering, Inc., October, 26, 2007.
14. Deer Valley townhomes – Riprap Study Memorandum, Smith & Annala Engineering Co., October 21, 2019.
15. Riprap Revetment Analysis for Deer Valley Townhomes, JE Fuller, November 20, 2019.

Appendix A

Firmette

National Flood Hazard Layer FIRMette

FEMA

33°41'19.38"N

111°55'24.54"W

111°54'47.08"W

33°40'49.44"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The base map shown complies with FEMA's base map accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/26/2018 at 7:37:10 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: base map imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

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Appendix B

Drainage Exhibits & Existing Condition Maps

Existing Drainage Conditions

Deer Valley Townhomes

Deer Valley Road and Miller Road

Project No. 0800

Date July 12, 2018

Terrascape consulting
civil engineering • surveying • urban planning

645 East Missouri Ave, Suite 160, Phoenix, Arizona 85012
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Plotted: 02/18/20 - 12:47 PM, By: pli
File: M:\0800 WPI - Miller & Deer Valley - Scottsdale\DWG\Preliminary\0800-EXCON.dwg, --> Layout1

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PRELIMINARY GRADING AND DRAINAGE PLAN FOR:
DEER VALLEY TOWNHOMES
N MILLER ROAD & E DEER VALLEY ROAD
SCOTTSDALE, ARIZONA

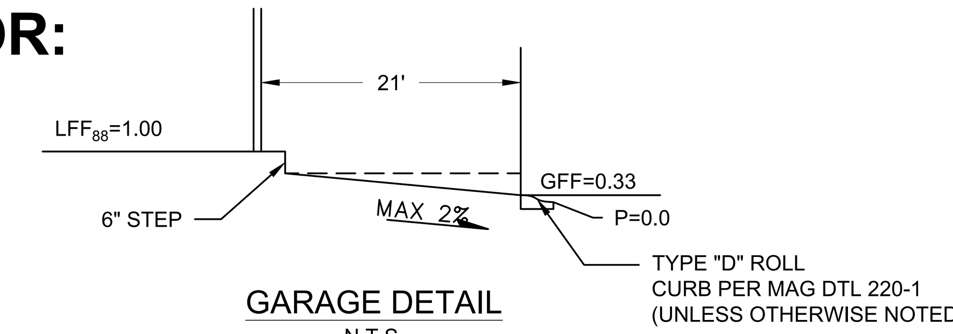
A PORTION OF THE SOUTHWEST QUARTER OF SECTION 14, TOWNSHIP 4 NORTH, RANGE 4 EAST OF THE GILA AND SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA.

Flow	
Q= CIA**	Q = Flow (cfs)
	C = Average Runoff Coefficient*
Q = 0.94 x 8.05 x 0.68	I = Precipitaion Intensity (100-yr, 5-min) (in/hr)
Q = 5.15 cfs	A = Net Area of Disturbed Area (ac)

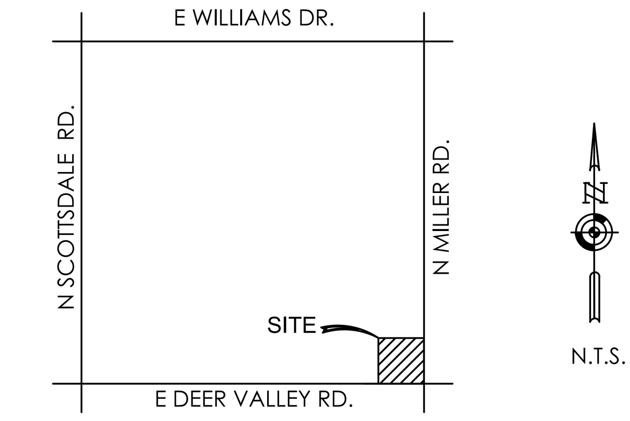
*C-Values are from FCDMC Hydrology Manual

First Flush Volume	
V= CDA**	V = First Flush Volume (cf)
	C = Average Runoff Coefficient*
V = 0.94 x 0.042 x 29,597	D = First Flush Precipitation Depth (1/2") (ft)
V = 1,168 cf	A = Net Area of Disturbed Area (sf)

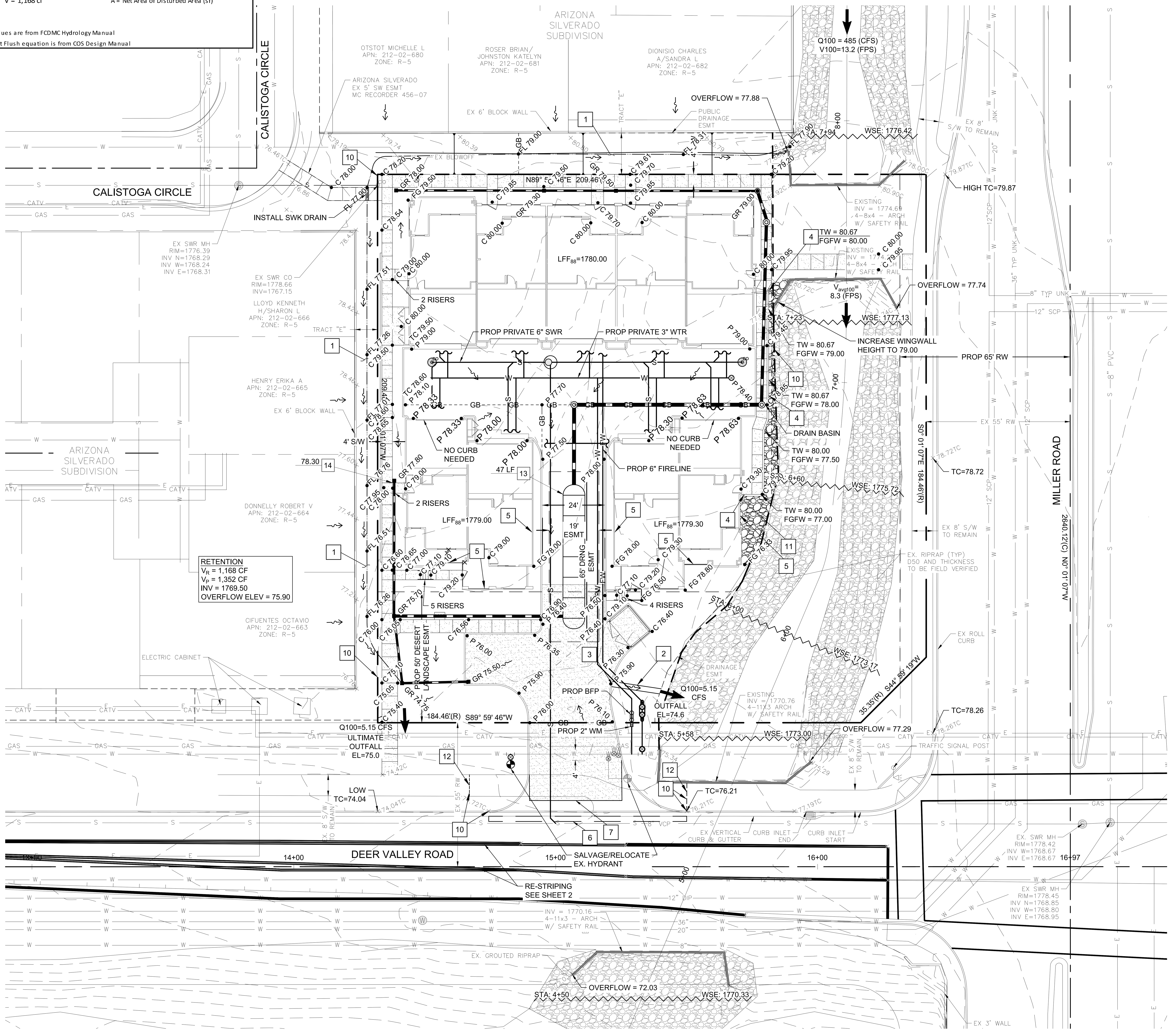
*C-Values are from FCDMC Hydrology Manual
**First Flush equation is from COS Design Manual



GARAGE DETAIL
N.T.S.



VICINITY MAP



OWNER / DEVELOPER

BEARDSLEY 22, INC
222 W LINGER LN, PHOENIX, AZ 85021

CONTACT: SCOTT WARD
PHONE: (480) 899-4330
EMAIL: WARDDEVELOPMENT@YAHOO.COM

ARCHITECT

WHITNEYBELL PERRY, INC
575 W CHANDLER BLVD, SUITE 123
CHANDLER, ARIZONA 85224

CONTACT: TERESA HILL
PHONE: (480) 857-8364
EMAIL: TERESA@WHITNEYBELLPERRY.COM

CIVIL ENGINEER

TERRASCAPE CONSULTING
645 EAST MISSOURI AVENUE, SUITE 160
PHOENIX, ARIZONA 85014

CONTACT: LISA NELSON, P.E.
PHONE: (480) 454-1807
FAX: (602) 230-2458
EMAIL: LNELSON@TERRASCAPE.US

PROJECT DATA:

APN:	212-02-010E
NET AREA:	0.68 ACRES
TOTAL DISTURBED AREA:	0.68 ACRES
PARCEL AREA:	1.00 ACRES

ADDRESS: 21818 N MILLER RD, SCOTTSDALE, AZ 85255

BASIS OF BEARING

THE SOUTH LINE OF SECTION 14, TOWNSHIP 4 NORTH, RANGE 4 EAST. SAID LINE HAVING AN ASSUMED BEARING OF N 89° 32' 09" E.

BENCHMARK

A CITY OF SCOTTSDALE BRASS CAP IN HANDHOLE AT THE INTERSECTION OF SCOTTSDALE ROAD AND DEER VALLEY ROAD, C.O.S ELEVATION = 1747.03 (NAVD 88).

FEMA FLOOD INFORMATION

FLOOD ZONE DESIGNATION "X" F.E.M.A. FLOOD INSURANCE RATE MAP, MAP NUMBER 04013C1320L, PANEL 1320 OF 4425, DATED AUGUST 25, 2017. ZONE "X" AREAS DETERMINED TO BE OUTSIDE OF 0.2% ANNUAL CHANCE FLOODPLAIN.

41715
LISA NELSON
02/05/20
ARIZONA U.S.A.

LEGEND

- BOUNDARY
- EX PROPERTY LINE
- SETBACK
- EASEMENT
- STORM DRAIN
- SANITARY SEWER LINE
- DOMESTIC WATERLINE
- FIRELINE
- DRYWELL
- STORMTECH RETENTION TANK
- GRADE BREAK LINE
- EROSION SETBACK
- FIRE HYDRANT
- CLEAN OUT WITH COLLAR
- CLEAN OUT
- VALVE
- 4' MANHOLE
- CATCH BASIN
- YARD DRAIN
- BACKFLOW PREVENTER
- WATER METER
- FINISHED GRADE
- HEC-RAS CROSS SECTIONS WATER SURFACE ELEVATION
- COLORED PORTLAND CEMENT CONCRETE

ABBREVIATIONS

BFP	BACKFLOW PREVENTOR	LS	LANDSCAPE
BLDG	BUILDING	MH	MANHOLE
C	CONCRETE	P	PAVEMENT
C&G	CURB AND GUTTER	PROP	PROPOSED
CO	CLEAN OUT	PUE	PUBLIC UTILITY EASEMENT
CMP	CORRUGATED METAL PIPE	RW	RIGHT OF WAY
DIA	DIAMETER	SB	SETBACK
EL/ELEV	ELEVATION	SS	SANITARY SEWER
ESMT	EASEMENT	S/W	SIDEWALK
EX	EXISTING	TC	TOP OF CURB
LFF_{88}	FINISHED FLOOR ELEVATION	TYP	TYPICAL
FGFW	FINISHED GRADE AT FOOT OF WALL	TW	TOP OF WALL
FL	FLOWLINE	V_P	VOLUME PROVIDED
G	GUTTER	V_R	VOLUME REQUIRED
GR	GRATE	WSE	WATER SURFACE ELEVATION
HP	HIGH POINT	WM	WATER METER
INV	INVERT		

PAVING, GRADING AND DRAINAGE NOTES

1. GRADE SWALE TO DRAIN
2. GRADE 4' WIDE DRAINAGE SWALE TO DRAIN; LINE WITH 4" DIA. LANDSCAPE ROCK.
3. 2' WIDE CURB OPENING.
4. RETAINING WALL WITH SAFETY RAIL. WALL HEIGHT VARIES, PER PLAN. WALL FOOTING SHALL EXTEND BELOW TOP OF BANK TURN DOWN FOR RIP RAP, WHERE APPLICABLE ALONG EX. CHANNEL.
5. EXPOSED STEM WALL; REFER TO ARCHITECTURAL PLANS.
6. MIN. 2' SAWCUT AND REMOVE EX. A.C.C.P. ROADWAY. PROTECT EXISTING ASPHALT CONCRETE TO REMAIN.
7. INSTALL M-2 DRIVEWAY PER C.O.S. STD. DTL. 2255; SIDEWALK MODIFIED PER PLAN.
8. WIDEN A.C.C.P. ROADWAY TO LIMITS SHOWN.
9. OBLITERATE PAVEMENT MARKINGS
10. MATCH EXISTING.
11. 2' DEEP RIP RAP D50 = 6" TO BE INSTALLED AGAINST RETAINING; MATCH EXISTING
12. SAWCUT, REMOVE, AND DISPOSE OF CONCRETE TO LIMITS SHOWN OR NEAREST EXPANSION JOINT, EXACT LIMITS TO BE DETERMINED IN THE FIELD. PROTECT EXISTING ASPHALT CONCRETE TO REMAIN.
13. INSTALL MC3500 (45" ARCH PIPE) STORMTECH RETENTION SYSTEM. SEE DETAIL SHEET 2. LENGTH PER PLAN.
14. LOCALIZED INLET OVERFLOW POINT. OVERFLOW ELEV. PER PLAN.

SCALE IN FEET
0 20 40

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DEER VALLEY TOWNHOMES

PRELIMINARY GRADING & DRAINAGE

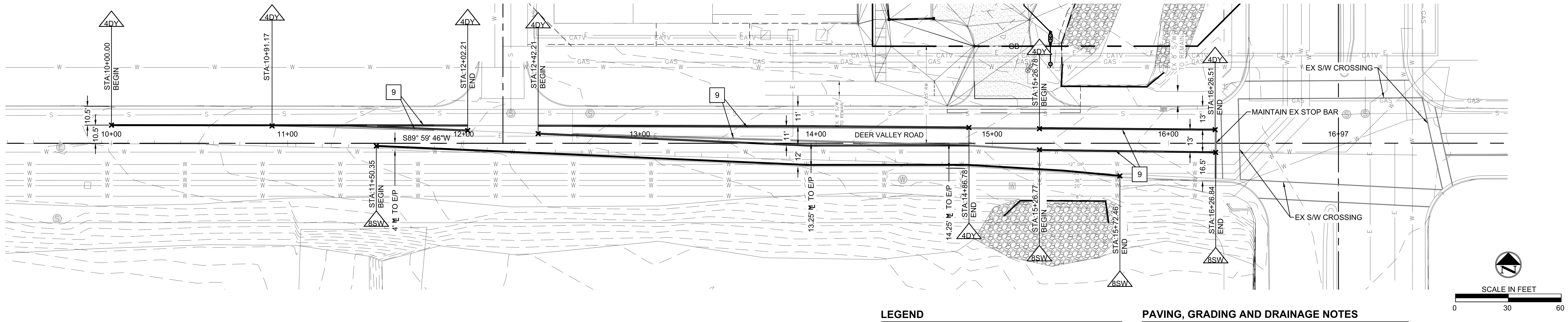
Contact Arizona 811 at least two full working days before you begin excavation
ARIZONA811
Call 811 or click Arizona811.com

DATE	DESCRIPTION
08/27/18	CITY SUBMITTAL
02/06/19	CITY SUBMITTAL
03/25/19	CITY SUBMITTAL
02/06/20	2ND DRB SUBMITTAL

CHECKED BY: LMN
DRAWN BY: CMA
TITLE: PRELIMINARY GRADING & DRAINAGE PLAN
SHEET No. 1 of 2
PROJECT No. 0800

3-ZN-2017

43-DR-2019
03/17/20



LEGEND

8SW	8" SOLID WHITE LINE
4DY	4" DOUBLE YELLOW LINE

PAVING, GRADING AND DRAINAGE NOTES

1. GRADE TO DRAIN
2. GRADE 4' WIDE DRAINAGE SWALE TO DRAIN; LINE WITH 4" DIA. LANDSCAPE ROCK.
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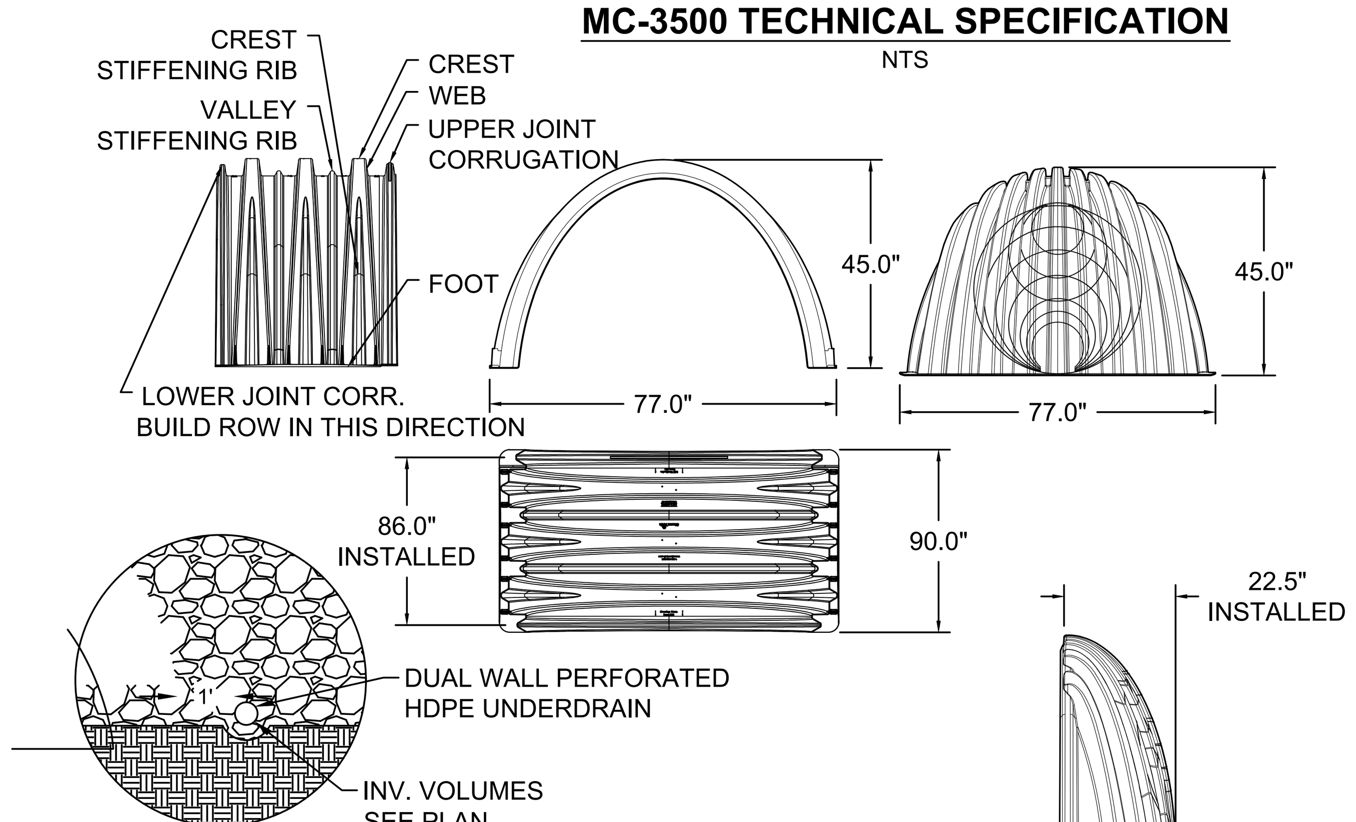
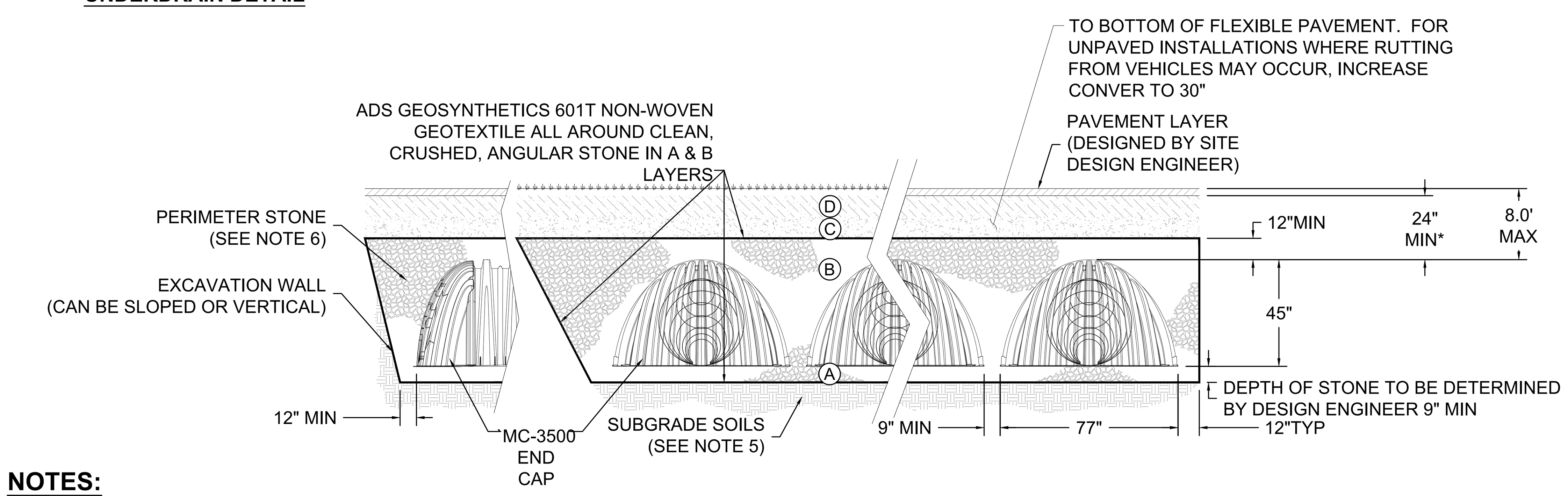
10. MATCH EXISTING.
11. 2' DEEP RIP RAP D50 = 6" TO BE INSTALLED AGAINST RETAINING; MATCH EXISTING

MC-3500 TECHNICAL SPECIFICATION

NTS



UNDERDRAIN DETAIL



NOTES:

1. MC-3500 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
2. MC-3500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDMENT, AND FILL MATERIALS.
4. THE "SITE DESIGN ENGINEER" REFERS TO THE ENGINEER RESPONSIBLE FOR THE DESIGN AND LAYOUT OF THE STORMTECH CHAMBERS FOR THIS PROJECT.
5. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
6. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
7. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.

Volume Provided				
Number of chambers		6 (1 PIPE)	Volume Per Chamber	110 cf
Number of End Caps		2	Volume Per End Cap	16 cf
Area		440 sf	Excavation Length	52 lf
Perimeter		121 ft	Excavation Width	8 lf
Stone above		12 in	Excavation Depth (Including cover)	6 lf
Stone below		9 in		
Voids in stone		40 %		
Length of Isolator Row		47 ft		
Volume in chambers	**# of Chambers * 109.9**	659 cf		
Volume in End Caps	**# of caps * 15.6**	31 cf		
Volume of excavation	**L X W X D**	2422 cf		
Amount of stone	**Vexc - Vchmb**	1731 cf		
Volume in stone	**Void % * $Amount_{stone}$**	693 cf		
Amount of Filter Fabric	**2*Area + Perimeter *(6 +Cover)**	1822 sf		
Volume Provided	**$V_{chmb} + V_{stone}$**	1352 cf		

NOTE: TOTAL LENGTH OF STORAGE TANK = CHAMBERS PLUS END CAPS. EACH CHAMBER IS 7.17 FT IN LENGTH AND EACH END CAP IS 1.88 FT IN LENGTH.

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02/05/20
ARIZONA U.S.A.

DEER VALLEY TOWNHOMES

PRELIMINARY GRADING & DRAINAGE

DATE	DESCRIPTION
08/27/18	CITY SUBMITTAL
02/06/19	CITY SUBMITTAL
03/25/19	CITY SUBMITTAL
02/06/20	2ND DRB SUBMITTAL

CHECKED BY: LMN

DRAWN BY: CMA

TITLE: PRELIMINARY GRADING & DRAINAGE PLAN

SHEET No. 2 of 2

PROJECT No. 0800

43-DR-2019
03/17/20

Appendix C

Calculations

First Flush Volume

V= CDA**

V = 0.94 x 0.042 x 29,597

V = 1,168 cf

V = First Flush Volume (cf)
C = Average Runoff Coefficient*
D = First Flush Precipitation Depth (1/2") (ft)
A = Net Area of Disturbed Area (sf)

*C-Values are from FCDMC Hydrology Manual
**First Flush equation is from COS Design Manual

Volume Provided

Number of chambers	6 *	Volume Per Chamber	110 cf
Number of End Caps	2 **	Volume Per End Cap	16 cf
Area	440 sf	Excavation Length	52 lf
Perimeter	121 ft	Excavation Width	8 lf
Stone above	12 in	Excavation Depth (Including cover)	6 lf
Stone below	9 in		
Voids in stone	40 %***		
Length of Isolator Row	47 ft (Isolator Row length is the total length of chambers and end caps installed.)		

Volume in chambers	**# of Chambers x 109.9**	659 cf
Volume in End Caps	**# of caps x 15.6**	31 cf
Volume of excavation	**L X W X D**	2422 cf
Amount of stone	**Vexc - Vchmb**	1731 cf
Volume in stone	**Void % x Amount$_{stone}$**	693 cf
Amount of Filter Fabric	**2 x Area + Perimeter x (6' +Stone Depth)*****	1822 sf (Stone Depth is the sum of Stone above and Stone below.)
Volume Provided	**$V_{chmb} + V_{stone}$**	1352 cf

*Each chamber is 7.17 ft in length installed for MC-3500.
**Each endcap is 1.88 ft in length installed for MC-3500.
***Data specified by ADS installation specifications.

Volume Required & Volume Waived

V = ΔC(R/12)A*

$\Delta C = C_{post} - C_{pre}$
= 0.94 - 0.44
= 0.5
V = 0.50 x (2.37/12) x 29,597
V = 2,923 cf

V = Stormwater storage volume required (cf)
ΔC = Increase in weighted average runoff coefficient over disturbed area**
R= 100-year/2-hour precipitation depth (in)***
A= Area of disturbed ground (sf)

$V_w = V - V_p$*

V_w = 2,923-1,352
V_w = 1,571 cf

V = Stormwater storage volume required (cf)
V_w = Volume waived (cf)
V_p = Volume provided (cf)****

*Equation from COS Request for Stormwater Storage Waiver
**C-Values are derived from FCDMC Hydrology Manual
***100-year 2-hour precipitation from NOAA
****Volume provided must be greater than or equal to First Flush Volume per COS Design Manual

43-DR-2019
03/17/20

NOAA Atlas 14, Volume 1, Version 5
Location name: Scottsdale, Arizona, USA*
Latitude: 33.6846°, Longitude: -111.9173°
Elevation: 1777.81 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.203 (0.169-0.249)	0.265 (0.222-0.326)	0.358 (0.296-0.438)	0.429 (0.353-0.523)	0.524 (0.425-0.636)	0.597 (0.477-0.720)	0.671 (0.528-0.807)	0.745 (0.577-0.896)	0.845 (0.637-1.02)	0.921 (0.681-1.11)
10-min	0.309 (0.257-0.380)	0.404 (0.338-0.496)	0.545 (0.451-0.667)	0.653 (0.537-0.796)	0.798 (0.646-0.969)	0.908 (0.727-1.10)	1.02 (0.803-1.23)	1.13 (0.878-1.36)	1.29 (0.970-1.55)	1.40 (1.04-1.69)
15-min	0.384 (0.319-0.471)	0.500 (0.419-0.615)	0.676 (0.559-0.827)	0.810 (0.666-0.987)	0.989 (0.801-1.20)	1.13 (0.901-1.36)	1.27 (0.996-1.52)	1.41 (1.09-1.69)	1.59 (1.20-1.92)	1.74 (1.28-2.10)
30-min	0.516 (0.429-0.634)	0.674 (0.564-0.828)	0.910 (0.753-1.11)	1.09 (0.898-1.33)	1.33 (1.08-1.62)	1.52 (1.21-1.83)	1.71 (1.34-2.05)	1.89 (1.47-2.28)	2.15 (1.62-2.58)	2.34 (1.73-2.82)
60-min	0.639 (0.531-0.784)	0.834 (0.698-1.02)	1.13 (0.932-1.38)	1.35 (1.11-1.65)	1.65 (1.34-2.00)	1.88 (1.50-2.26)	2.11 (1.66-2.54)	2.34 (1.81-2.82)	2.66 (2.01-3.20)	2.90 (2.14-3.49)
2-hr	0.744 (0.626-0.894)	0.963 (0.813-1.16)	1.28 (1.07-1.54)	1.53 (1.26-1.83)	1.86 (1.52-2.21)	2.11 (1.71-2.50)	2.37 (1.88-2.81)	2.62 (2.06-3.11)	2.97 (2.28-3.52)	3.24 (2.43-3.86)
3-hr	0.814 (0.684-0.995)	1.04 (0.880-1.28)	1.36 (1.14-1.66)	1.62 (1.34-1.96)	1.97 (1.61-2.38)	2.25 (1.82-2.70)	2.54 (2.01-3.05)	2.85 (2.22-3.41)	3.26 (2.47-3.91)	3.60 (2.66-4.31)
6-hr	0.976 (0.840-1.16)	1.23 (1.06-1.46)	1.57 (1.35-1.86)	1.84 (1.56-2.17)	2.21 (1.85-2.59)	2.50 (2.06-2.91)	2.80 (2.27-3.26)	3.11 (2.48-3.62)	3.52 (2.73-4.10)	3.84 (2.92-4.48)
12-hr	1.12 (0.967-1.31)	1.41 (1.22-1.65)	1.77 (1.53-2.07)	2.06 (1.77-2.40)	2.46 (2.08-2.85)	2.75 (2.30-3.19)	3.07 (2.53-3.55)	3.38 (2.75-3.91)	3.79 (3.01-4.41)	4.11 (3.20-4.81)
24-hr	1.31 (1.15-1.52)	1.67 (1.46-1.93)	2.16 (1.89-2.50)	2.55 (2.22-2.95)	3.11 (2.68-3.58)	3.55 (3.03-4.08)	4.01 (3.39-4.62)	4.49 (3.75-5.18)	5.16 (4.23-5.98)	5.70 (4.60-6.65)
2-day	1.44 (1.25-1.66)	1.84 (1.60-2.12)	2.41 (2.10-2.77)	2.87 (2.49-3.30)	3.52 (3.02-4.04)	4.03 (3.43-4.63)	4.58 (3.86-5.27)	5.15 (4.29-5.95)	5.95 (4.87-6.91)	6.59 (5.32-7.71)
3-day	1.54 (1.35-1.77)	1.98 (1.73-2.26)	2.61 (2.28-2.98)	3.12 (2.72-3.56)	3.85 (3.33-4.39)	4.44 (3.80-5.07)	5.07 (4.30-5.81)	5.73 (4.81-6.60)	6.68 (5.50-7.73)	7.45 (6.05-8.69)
4-day	1.65 (1.45-1.88)	2.11 (1.86-2.41)	2.81 (2.47-3.19)	3.37 (2.95-3.82)	4.18 (3.63-4.75)	4.84 (4.17-5.51)	5.56 (4.74-6.34)	6.32 (5.33-7.25)	7.41 (6.14-8.56)	8.31 (6.78-9.67)
7-day	1.87 (1.64-2.15)	2.40 (2.10-2.74)	3.19 (2.79-3.65)	3.84 (3.34-4.38)	4.77 (4.12-5.44)	5.53 (4.74-6.32)	6.35 (5.39-7.29)	7.24 (6.06-8.35)	8.50 (7.00-9.88)	9.55 (7.74-11.2)
10-day	2.04 (1.79-2.33)	2.61 (2.30-2.99)	3.47 (3.04-3.95)	4.17 (3.63-4.74)	5.16 (4.47-5.87)	5.97 (5.12-6.80)	6.84 (5.81-7.81)	7.77 (6.53-8.92)	9.09 (7.51-10.5)	10.2 (8.27-11.9)
20-day	2.54 (2.24-2.90)	3.28 (2.89-3.73)	4.34 (3.81-4.92)	5.16 (4.51-5.84)	6.27 (5.46-7.12)	7.15 (6.18-8.12)	8.05 (6.92-9.19)	8.99 (7.65-10.3)	10.3 (8.63-11.9)	11.3 (9.37-13.1)
30-day	3.00 (2.63-3.41)	3.86 (3.40-4.39)	5.10 (4.48-5.79)	6.06 (5.31-6.86)	7.36 (6.41-8.34)	8.37 (7.24-9.49)	9.42 (8.10-10.7)	10.5 (8.94-11.9)	12.0 (10.1-13.7)	13.1 (10.9-15.1)
45-day	3.52 (3.11-3.99)	4.54 (4.01-5.15)	6.00 (5.30-6.79)	7.11 (6.25-8.04)	8.59 (7.51-9.73)	9.73 (8.45-11.0)	10.9 (9.40-12.4)	12.1 (10.3-13.8)	13.7 (11.6-15.8)	14.9 (12.5-17.4)
60-day	3.92 (3.47-4.43)	5.07 (4.49-5.73)	6.69 (5.91-7.54)	7.88 (6.94-8.89)	9.46 (8.29-10.7)	10.7 (9.28-12.1)	11.9 (10.3-13.5)	13.1 (11.2-14.9)	14.7 (12.5-16.9)	15.9 (13.4-18.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

43-DR-2019
03/17/20

NOAA Atlas 14, Volume 1, Version 5
Location name: Scottsdale, Arizona, USA*
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Elevation: 1777.81 ft**
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Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	2.44 (2.03-2.99)	3.18 (2.66-3.91)	4.30 (3.55-5.26)	5.15 (4.24-6.28)	6.29 (5.10-7.63)	7.16 (5.72-8.64)	8.05 (6.34-9.68)	8.94 (6.92-10.8)	10.1 (7.64-12.2)	11.1 (8.17-13.3)
10-min	1.85 (1.54-2.28)	2.42 (2.03-2.98)	3.27 (2.71-4.00)	3.92 (3.22-4.78)	4.79 (3.88-5.81)	5.45 (4.36-6.57)	6.13 (4.82-7.37)	6.80 (5.27-8.18)	7.72 (5.82-9.28)	8.41 (6.22-10.1)
15-min	1.54 (1.28-1.88)	2.00 (1.68-2.46)	2.70 (2.24-3.31)	3.24 (2.66-3.95)	3.96 (3.20-4.80)	4.50 (3.60-5.43)	5.06 (3.98-6.09)	5.62 (4.35-6.76)	6.38 (4.81-7.67)	6.95 (5.14-8.38)
30-min	1.03 (0.858-1.27)	1.35 (1.13-1.66)	1.82 (1.51-2.23)	2.18 (1.80-2.66)	2.66 (2.16-3.23)	3.03 (2.43-3.66)	3.41 (2.68-4.10)	3.79 (2.93-4.55)	4.29 (3.24-5.17)	4.68 (3.46-5.65)
60-min	0.639 (0.531-0.784)	0.834 (0.698-1.02)	1.13 (0.932-1.38)	1.35 (1.11-1.65)	1.65 (1.34-2.00)	1.88 (1.50-2.26)	2.11 (1.66-2.54)	2.34 (1.81-2.82)	2.66 (2.01-3.20)	2.90 (2.14-3.49)
2-hr	0.372 (0.313-0.447)	0.482 (0.406-0.580)	0.640 (0.537-0.768)	0.762 (0.632-0.913)	0.928 (0.762-1.11)	1.05 (0.853-1.25)	1.18 (0.942-1.40)	1.31 (1.03-1.55)	1.49 (1.14-1.76)	1.62 (1.22-1.93)
3-hr	0.271 (0.228-0.331)	0.347 (0.293-0.426)	0.454 (0.381-0.554)	0.538 (0.447-0.654)	0.656 (0.536-0.791)	0.749 (0.605-0.900)	0.846 (0.671-1.02)	0.947 (0.739-1.14)	1.09 (0.822-1.30)	1.20 (0.885-1.44)
6-hr	0.163 (0.140-0.193)	0.206 (0.177-0.244)	0.263 (0.225-0.310)	0.308 (0.261-0.362)	0.370 (0.309-0.432)	0.418 (0.344-0.487)	0.468 (0.380-0.544)	0.519 (0.413-0.605)	0.588 (0.456-0.685)	0.642 (0.487-0.749)
12-hr	0.093 (0.080-0.108)	0.117 (0.101-0.137)	0.147 (0.127-0.172)	0.171 (0.147-0.199)	0.204 (0.172-0.237)	0.229 (0.191-0.265)	0.254 (0.210-0.294)	0.280 (0.228-0.324)	0.315 (0.250-0.366)	0.341 (0.266-0.399)
24-hr	0.055 (0.048-0.063)	0.070 (0.061-0.080)	0.090 (0.079-0.104)	0.106 (0.093-0.123)	0.129 (0.112-0.149)	0.148 (0.126-0.170)	0.167 (0.141-0.193)	0.187 (0.156-0.216)	0.215 (0.176-0.249)	0.237 (0.192-0.277)
2-day	0.030 (0.026-0.035)	0.038 (0.033-0.044)	0.050 (0.044-0.058)	0.060 (0.052-0.069)	0.073 (0.063-0.084)	0.084 (0.071-0.096)	0.095 (0.080-0.110)	0.107 (0.089-0.124)	0.124 (0.101-0.144)	0.137 (0.111-0.160)
3-day	0.021 (0.019-0.025)	0.027 (0.024-0.031)	0.036 (0.032-0.041)	0.043 (0.038-0.049)	0.053 (0.046-0.061)	0.062 (0.053-0.070)	0.070 (0.060-0.081)	0.080 (0.067-0.092)	0.093 (0.076-0.107)	0.103 (0.084-0.121)
4-day	0.017 (0.015-0.020)	0.022 (0.019-0.025)	0.029 (0.026-0.033)	0.035 (0.031-0.040)	0.044 (0.038-0.049)	0.050 (0.043-0.057)	0.058 (0.049-0.066)	0.066 (0.055-0.076)	0.077 (0.064-0.089)	0.087 (0.071-0.101)
7-day	0.011 (0.010-0.013)	0.014 (0.012-0.016)	0.019 (0.017-0.022)	0.023 (0.020-0.026)	0.028 (0.025-0.032)	0.033 (0.028-0.038)	0.038 (0.032-0.043)	0.043 (0.036-0.050)	0.051 (0.042-0.059)	0.057 (0.046-0.067)
10-day	0.008 (0.007-0.010)	0.011 (0.010-0.012)	0.014 (0.013-0.016)	0.017 (0.015-0.020)	0.022 (0.019-0.024)	0.025 (0.021-0.028)	0.028 (0.024-0.033)	0.032 (0.027-0.037)	0.038 (0.031-0.044)	0.042 (0.034-0.049)
20-day	0.005 (0.005-0.006)	0.007 (0.006-0.008)	0.009 (0.008-0.010)	0.011 (0.009-0.012)	0.013 (0.011-0.015)	0.015 (0.013-0.017)	0.017 (0.014-0.019)	0.019 (0.016-0.021)	0.021 (0.018-0.025)	0.023 (0.020-0.027)
30-day	0.004 (0.004-0.005)	0.005 (0.005-0.006)	0.007 (0.006-0.008)	0.008 (0.007-0.010)	0.010 (0.009-0.012)	0.012 (0.010-0.013)	0.013 (0.011-0.015)	0.015 (0.012-0.017)	0.017 (0.014-0.019)	0.018 (0.015-0.021)
45-day	0.003 (0.003-0.004)	0.004 (0.004-0.005)	0.006 (0.005-0.006)	0.007 (0.006-0.007)	0.008 (0.007-0.009)	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.011 (0.010-0.013)	0.013 (0.011-0.015)	0.014 (0.012-0.016)
60-day	0.003 (0.002-0.003)	0.004 (0.003-0.004)	0.005 (0.004-0.005)	0.005 (0.005-0.006)	0.007 (0.006-0.007)	0.007 (0.006-0.008)	0.008 (0.007-0.009)	0.009 (0.008-0.010)	0.010 (0.009-0.012)	0.011 (0.009-0.013)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

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PF graphical

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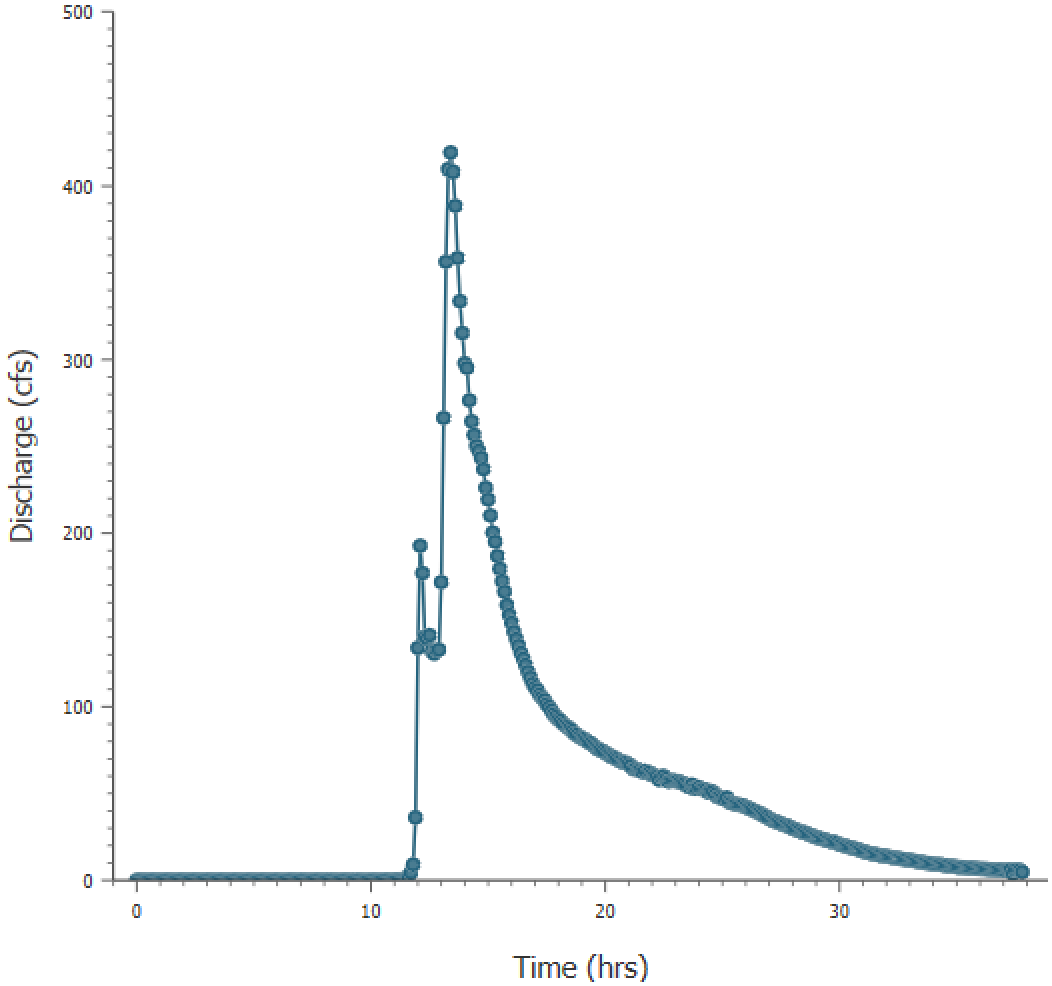
Pinnacle Peak West ADMS - FLO-2D
Channel Hydrograph for Sum - All
Peak 423 cfs at 13.4 hrs



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Appendix D

Supplemental Information

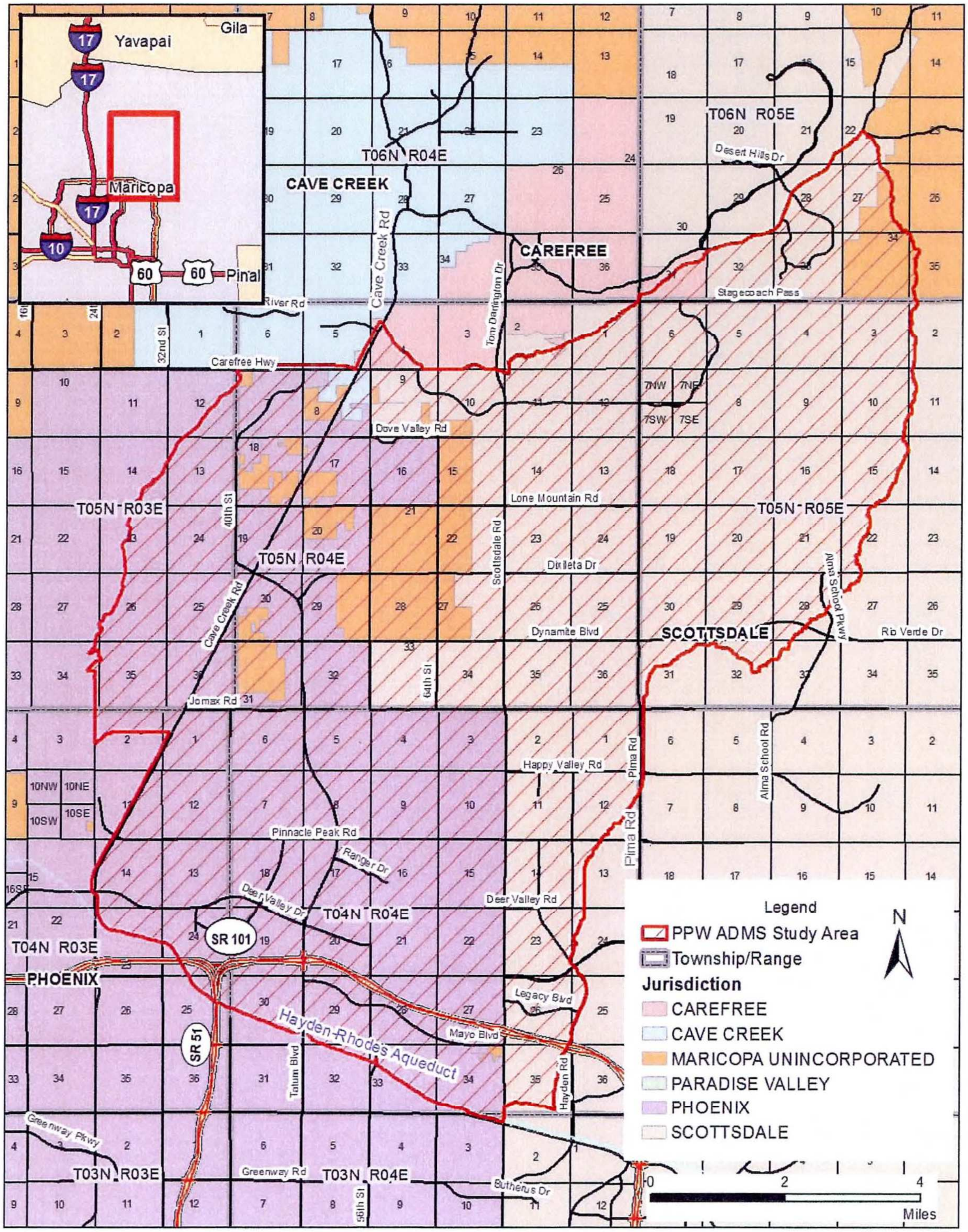

Figure 1. PPW ADMS Vicinity Map

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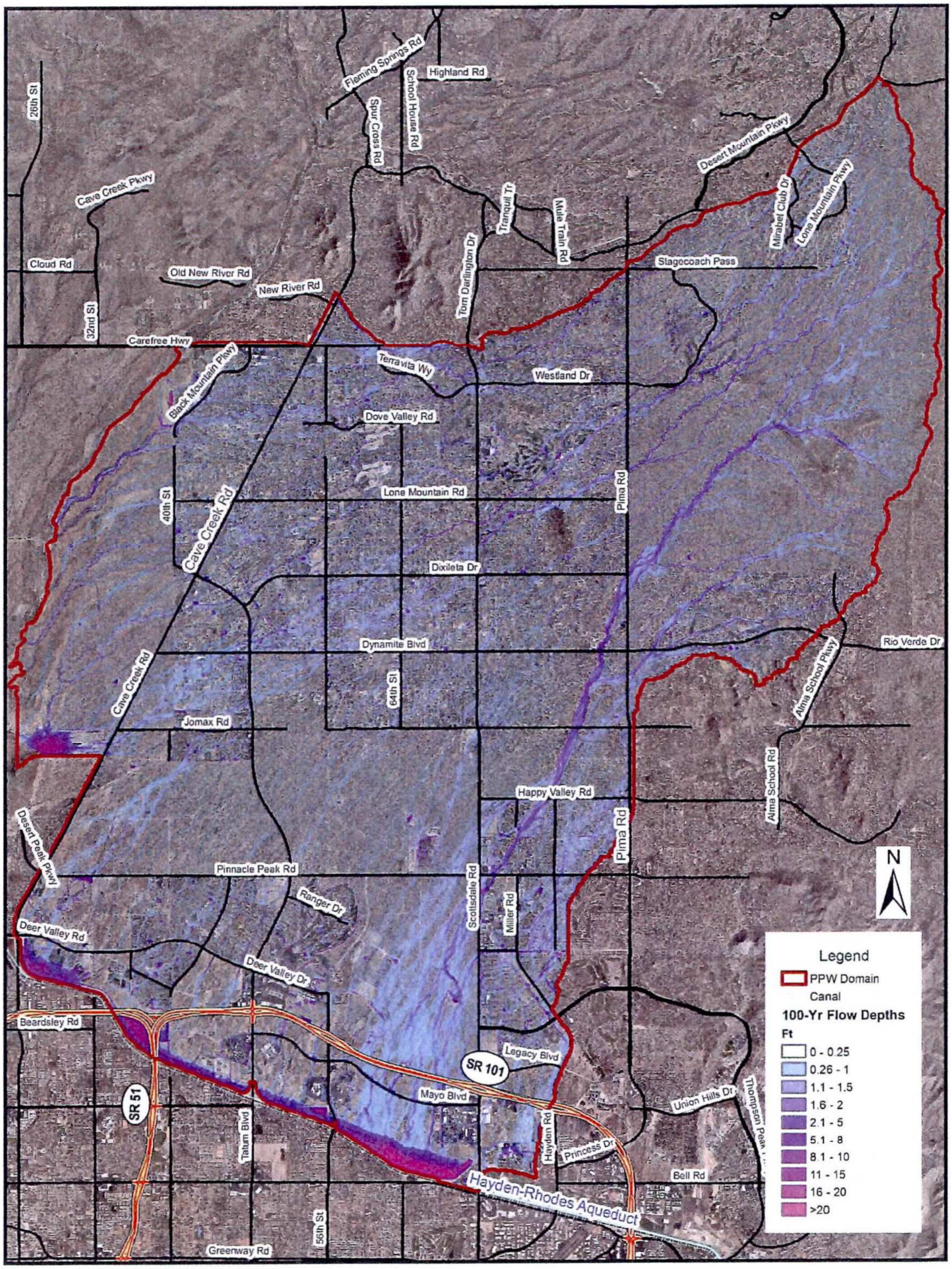


Figure 3. 100-Year Flow Depth Results

43-DR-2019
03/17/20

121_PinnaclePeakWest - Lower Rawhide 100YR24HR With Walls

July 13, 2018

1:480

0 20 40 80 ft

0 5 10 20 m

43-DR-2019
03/17/20

121_PinnaclePeakWest - Lower Rawhide 100YR24HR With Walls

May 17, 2018

1:9,600

0 600 1,200 2,400 ft

0 190 380 760 m

43-DR-2019
03/17/20

ADVANCED DRAINAGE SYSTEMS, INC.

Deer Valley Townhomes at Miller Rd and Deer Valley Rd

Scottsdale, Arizona

STORMTECH CHAMBER SPECIFICATIONS

1. CHAMBERS SHALL BE STORMTECH MC-3500 OR APPROVED EQUAL.
2. CHAMBERS SHALL BE MADE FROM VIRGIN, IMPACT-MODIFIED POLYPROPYLENE COPOLYMERS.
3. CHAMBER ROWS SHALL PROVIDE CONTINUOUS, UNOBSTRUCTED INTERNAL SPACE WITH NO INTERNAL SUPPORT PANELS THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION.
4. THE STRUCTURAL DESIGN OF THE CHAMBERS, THE STRUCTURAL BACKFILL, AND THE INSTALLATION REQUIREMENTS SHALL ENSURE THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET FOR: 1) LONG-DURATION DEAD LOADS AND 2) SHORT-DURATION LIVE LOADS, BASED ON THE AASHTO DESIGN TRUCK WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.
5. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
6. CHAMBERS SHALL BE DESIGNED AND ALLOWABLE LOADS DETERMINED IN ACCORDANCE WITH ASTM F2787, "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
7. ONLY CHAMBERS THAT ARE APPROVED BY THE SITE DESIGN ENGINEER WILL BE ALLOWED. THE CHAMBER MANUFACTURER SHALL SUBMIT THE FOLLOWING UPON REQUEST TO THE SITE DESIGN ENGINEER FOR APPROVAL BEFORE DELIVERING CHAMBERS TO THE PROJECT SITE:
   a. A STRUCTURAL EVALUATION SEALED BY A REGISTERED PROFESSIONAL ENGINEER THAT DEMONSTRATES THAT THE SAFETY FACTORS ARE GREATER THAN OR EQUAL TO 1.95 FOR DEAD LOAD AND 1.75 FOR LIVE LOAD, THE MINIMUM REQUIRED BY ASTM F2787 AND BY AASHTO FOR THERMOPLASTIC PIPE.
   b. A STRUCTURAL EVALUATION SEALED BY A REGISTERED PROFESSIONAL ENGINEER THAT DEMONSTRATES THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET. THE 50 YEAR CREEP MODULUS DATA SPECIFIED IN ASTM F2418 MUST BE USED AS PART OF THE AASHTO STRUCTURAL EVALUATION TO VERIFY LONG-TERM PERFORMANCE.
   c. STRUCTURAL CROSS SECTION DETAIL ON WHICH THE STRUCTURAL EVALUATION IS BASED.
8. CHAMBERS AND END CAPS SHALL BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.

IMPORTANT - NOTES FOR THE BIDDING AND INSTALLATION OF MC-3500 CHAMBER SYSTEM

1. STORMTECH MC-3500 CHAMBERS SHALL NOT BE INSTALLED UNTIL THE MANUFACTURER'S REPRESENTATIVE HAS COMPLETED A PRE-CONSTRUCTION MEETING WITH THE INSTALLERS.
2. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. CHAMBERS ARE NOT TO BE BACKFILLED WITH A DOZER OR AN EXCAVATOR SITUATED OVER THE CHAMBERS.

   STORMTECH RECOMMENDS 3 BACKFILL METHODS:
   - STONESHOOTER LOCATED OFF THE CHAMBER BED.
   - BACKFILL AS ROWS ARE BUILT USING AN EXCAVATOR ON THE FOUNDATION STONE OR SUBGRADE.
   - BACKFILL FROM OUTSIDE THE EXCAVATION USING A LONG BOOM HOE OR EXCAVATOR.
4. THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
5. JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
6. MAINTAIN MINIMUM - 9" (230 mm) SPACING BETWEEN THE CHAMBER ROWS.
7. INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM OF 12" (300 mm) INTO CHAMBER END CAPS.
8. EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE 3/4-2" (20-50 mm) MEETING THE AASHTO M43 DESIGNATION OF #3 OR #4.
9. STONE MUST BE PLACED ON THE TOP CENTER OF THE CHAMBER TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING..
10. ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

NOTES FOR CONSTRUCTION EQUIPMENT

1. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
2. THE USE OF EQUIPMENT OVER MC-3500 CHAMBERS IS LIMITED:
   - NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS.
   - NO RUBBER TIRED LOADER, DUMP TRUCK, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
   - WEIGHT LIMITS FOR CONSRUCTION EQUIPMENT CAN BE FOUND IN THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. FULL 36" (900 mm) OF STABILIZED COVER MATERIALS OVER THE CHAMBERS IS REQUIRED FOR DUMP TRUCK TRAVEL OR DUMPING.

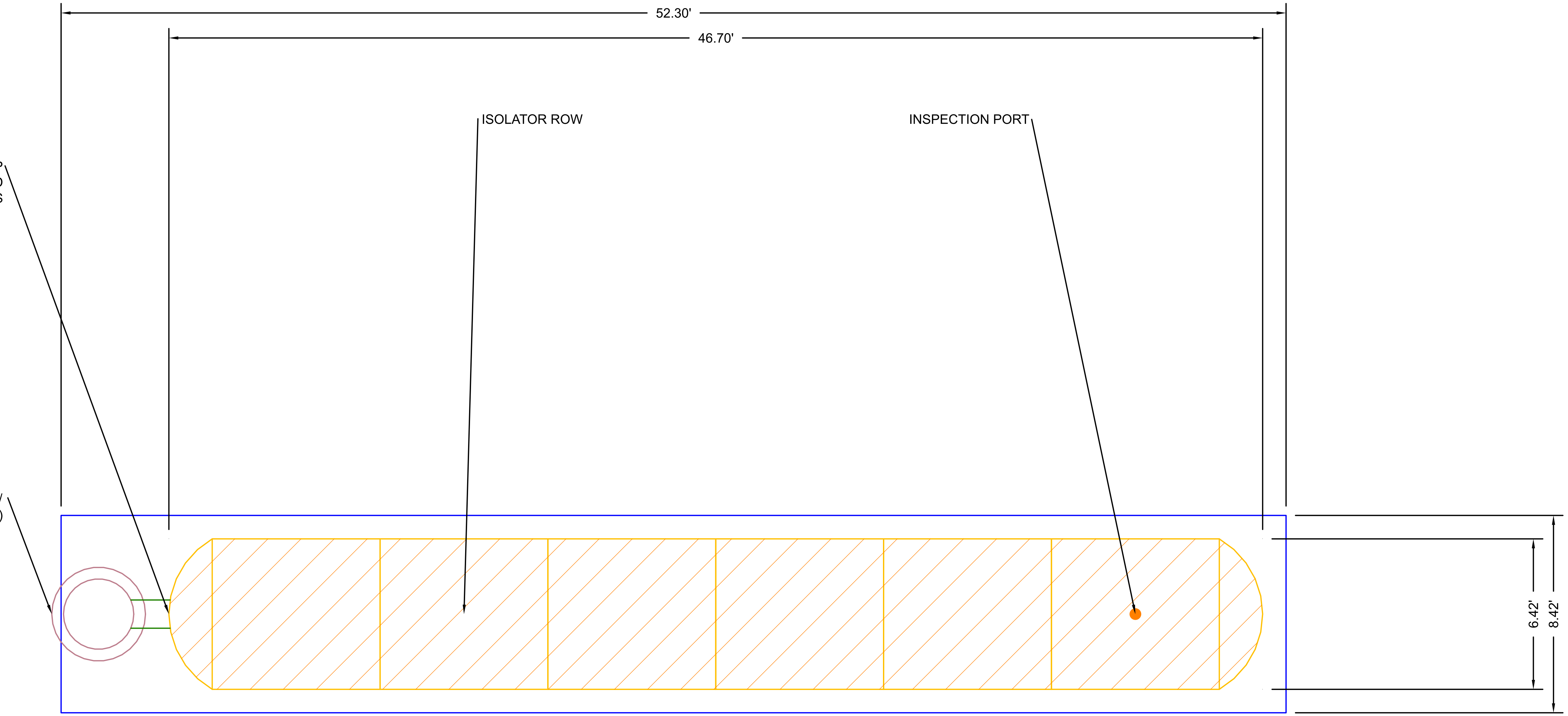
USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY USING THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.

CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

CONCEPTUAL LAYOUT

COMPUTER GENERATED CONCEPTUAL LAYOUT - NOT FOR CONSTRUCTION

(6) STORMTECH MC-3500 CHAMBERS
(2) STORMTECH MC-3500 END CAPS
INSTALLED WITH 12 " COVER STONE, 9 " BASE STONE, 40% STONE VOID
INSTALLED SYSTEM VOLUME: 1382 CF
AREA OF SYSTEM: 440 **FT²**
PERIMETER OF SYSTEM: 121 **FT**



Deer Valley Townhomes at Miller Rd and Deer Valley
Scottsdale, Arizona

DATE: 07/06/2018 DRAWN: BD
PROJECT #: Tool CHECKED: ---

REV	DRW	CHK	DESCRIPTION

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NOT TO SCALE

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SHEET
2 OF 5

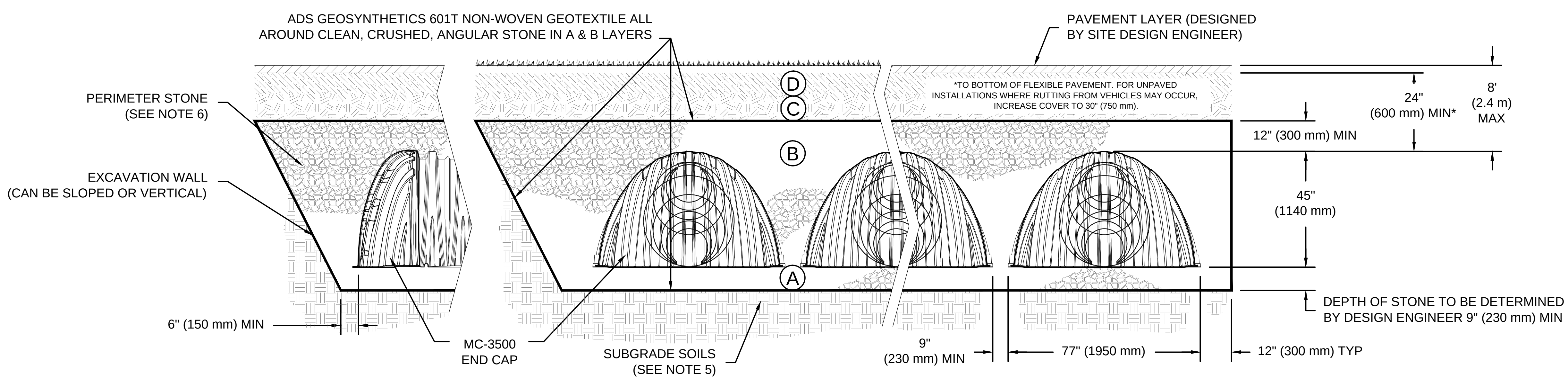
43-DR-2019
03/17/20

ACCEPTABLE FILL MATERIALS: STORMTECH MC-3500 CHAMBER SYSTEMS

MATERIAL LOCATION		DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1, A-2-4, A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE, NOMINAL SIZE DISTRIBUTION BETWEEN 3/4-2 INCH (20-50 mm)	AASHTO M43[1] 3, 4	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE, NOMINAL SIZE DISTRIBUTION BETWEEN 3/4-2 INCH (20-50 mm)	AASHTO M43[1] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE. [2,3]

PLEASE NOTE:

1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.



NOTES:

1. MC-3500 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
2. MC-3500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDMENT, AND FILL MATERIALS.
4. THE "SITE DESIGN ENGINEER" REFERS TO THE ENGINEER RESPONSIBLE FOR THE DESIGN AND LAYOUT OF THE STORMTECH CHAMBERS FOR THIS PROJECT.
5. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
6. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
7. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.

Deer Valley Townhomes at Miller Rd and Deer Va
Scottsdale, Arizona

DATE: 07/06/2018 DRAWN: BD
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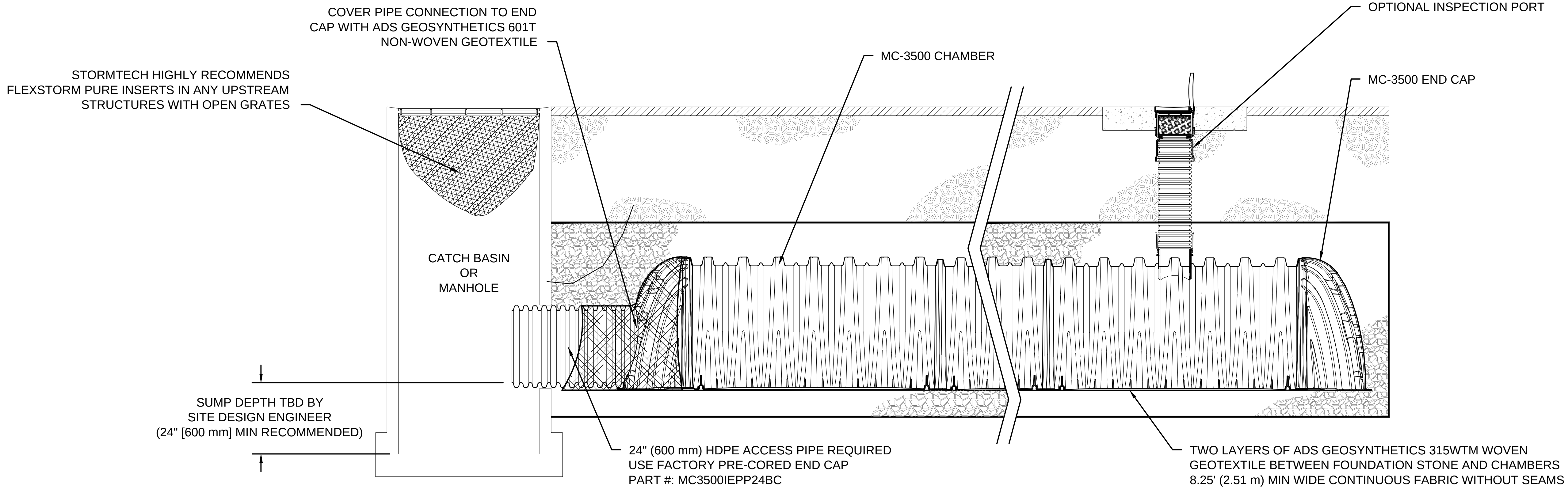


MC-3500 ISOLATOR ROW DETAIL

NTS

INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

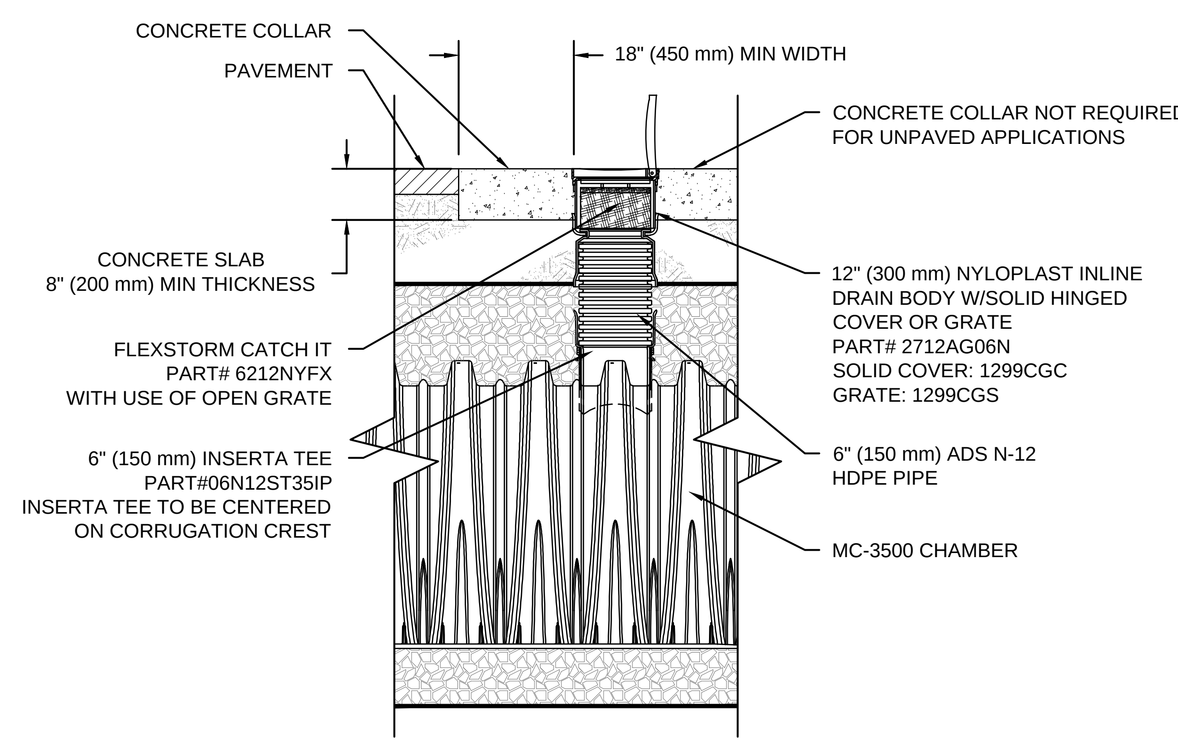
STEP 2) CLEAN OUT ISOLATOR ROW USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.
2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.



MC-3500 6" INSPECTION PORT DETAIL

NTS

Deer Valley Townhomes at Miller Rd and Deer Valley
Scottsdale, Arizona

DATE: 07/06/2018 DRAWN: BD
PROJECT #: Tool CHECKED: ---

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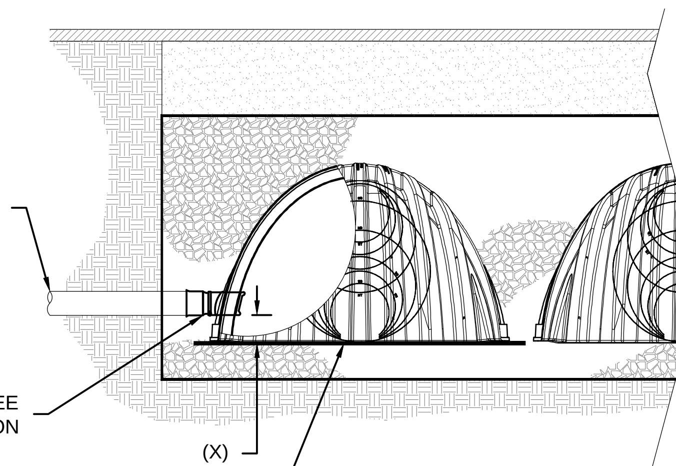
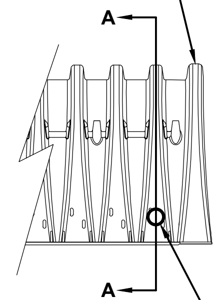
INSERTA TEE DETAIL

NTS



SECTION A-A



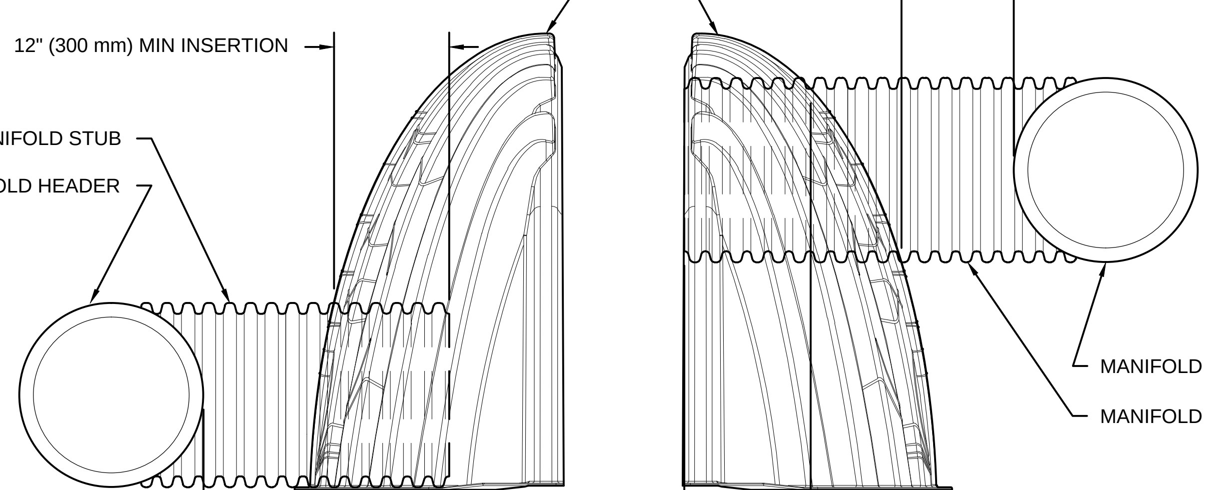
SIDE VIEW

CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
SC-310	6" (150 mm)	4" (100 mm)
SC-740	10" (250 mm)	4" (100 mm)
DC-780	10" (250 mm)	4" (100 mm)
MC-3500	12" (300 mm)	6" (150 mm)
MC-4500	12" (300 mm)	8" (200 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 35, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON		

NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS.
CONTACT STORMTECH FOR MORE INFORMATION.

MC-SERIES END CAP INSERTION DETAIL

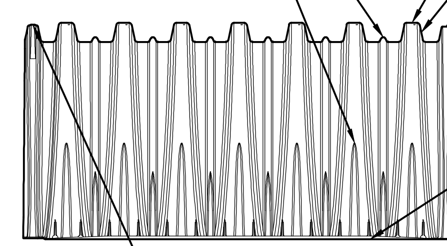
NTS

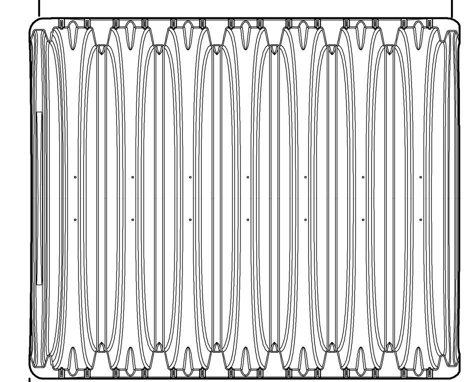


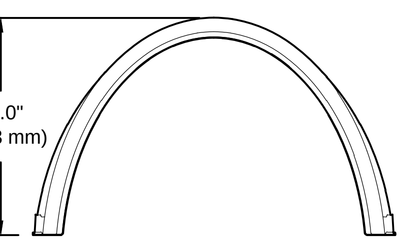
NOTE: MANIFOLD STUB MUST BE LAID HORIZONTAL
FOR A PROPER FIT IN END CAP OPENING.

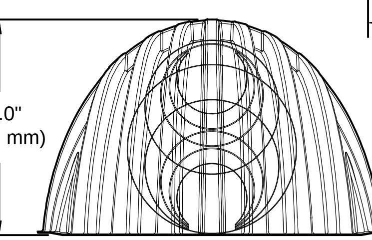
MC-3500 TECHNICAL SPECIFICATION

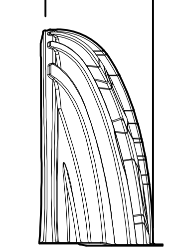
NTS











NOMINAL CHAMBER SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	77.0" X 45.0" X 86.0"	(1956 mm X 1143 mm X 2184 mm)
CHAMBER STORAGE	109.9 CUBIC FEET	(3.11 m³)
MINIMUM INSTALLED STORAGE*	178.9 CUBIC FEET	(5.06 m³)
WEIGHT	135.0 lbs.	(61.2 kg)

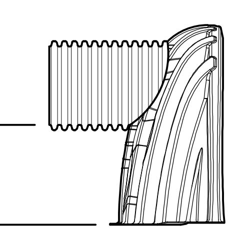
NOMINAL END CAP SPECIFICATIONS

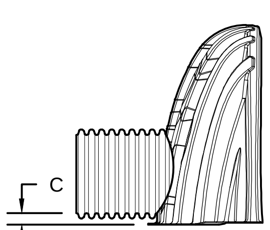
SIZE (W X H X INSTALLED LENGTH)	77.0" X 45.0" X 22.5"	(1956 mm X 1143 mm X 571 mm)
END CAP STORAGE	14.9 CUBIC FEET	(0.42 m³)
MINIMUM INSTALLED STORAGE*	46.0 CUBIC FEET	(1.30 m³)
WEIGHT	50.0 lbs.	(22.7 kg)

*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION AND BETWEEN CHAMBERS, 12" (305 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY

STUBS AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
STUBS AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"

PART #	STUB	B	C
MC3500IEPP06T	6" (150 mm)	33.21" (844 mm)	---
MC3500IEPP06B		---	0.66" (17 mm)
MC3500IEPP08T	8" (200 mm)	31.16" (791 mm)	---
MC3500IEPP08B		---	0.81" (21 mm)
MC3500IEPP10T	10" (250 mm)	29.04" (738 mm)	---
MC3500IEPP10B		---	0.93" (24 mm)
MC3500IEPP12T	12" (300 mm)	26.36" (670 mm)	---
MC3500IEPP12B		---	1.35" (34 mm)
MC3500IEPP15T	15" (375 mm)	23.39" (594 mm)	---
MC3500IEPP15B		---	1.50" (38 mm)
MC3500IEPP18TC	18" (450 mm)	20.03" (509 mm)	---
MC3500IEPP18BC		---	1.77" (45 mm)
MC3500IEPP24TC	24" (600 mm)	14.48" (368 mm)	---
MC3500IEPP24BC		---	2.06" (52 mm)
MC3500IEPP30BC	30" (750 mm)	---	





NOTE: ALL DIMENSIONS ARE NOMINAL

CUSTOM PRECORED INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS.
CUSTOM INVERT LOCATIONS ON THE MC-3500 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm)
THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHTEST POSSIBLE FOR THE PIPE SIZE.

Deer Valley Townhomes at Miller Rd and Deer Va
Scottsdale, Arizona

DATE: 07/06/2018 DRAWN: BD
PROJECT #: Tool CHECKED: ---

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REV	DRW	CHK	DESCRIPTION
			Deer Valley

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5 OF 5

43-DR-2019
03/17/20

Request for Stormwater Storage Waiver

CITY OF SCOTTSDALE

City of Scottsdale Plan/Case Numbers:

43 - DR - 2019 ____ - PP - ____ PC#________

Requests for stormwater storage waivers are reviewed as part of case submittals for the associated project. This form should be included in the preliminary drainage report with the applicant's portion completed. The preliminary drainage report shall include supporting documentation and analysis as needed to support the requested wavier.

Date 02/18/2020 Project Name Dear Valley Townhomes

Project Location NWC N Miller Road & E Deer Valley Road

Applicant Contact Lisa M. Nelson, P.E. Company Name Terrascape Consulting, LLC

Phone 480-454-1807 E-mail lnelson@terrascape.us

Address 645 E. Missouri Ave Suite 160, Phoenix, AZ 85012

Waiver Criteria

A project must meet at least one of three criteria listed below for the city to consider waiving some or all required stormwater storage. **However, regardless of the criteria, a waiver will only be granted if the applicant can demonstrate that the effect of a waiver will not increase the potential for flooding on any property.** Check the applicable box and provide a signed and sealed engineering report and supporting engineering analysis that demonstrate the project meets the criteria and that the effect of a waiver will not increase the potential for flooding on any property.

If the runoff for the project has been included in a storage facility at another location, the applicant must demonstrate that the stormwater storage facility was specifically designed to accommodate runoff from the subject property and that the runoff will be conveyed to this location through an adequately designed conveyance facility.

It should be noted that reductions in stormwater storage relating to

- [x] 1. The development is adjacent to a conveyance facility that an engineering analysis shows is designed and constructed to handle the additional runoff from the site as a result of development.
- [ ] 2. The development is on a parcel less than one-half acre in size.
- [ ] 3. Stormwater storage requirements conflict with requirements of the Environmentally Sensitive Lands Ordinance (ESLO).

For a full storage waiver, a conflict with ESLO is limited to:

- Property located in the hillside landform as defined in the city Zoning Ordinance
- Property in the upper desert landform that has a land slope steeper than 5% as defined in the city Zoning Ordinance
- Property within the ESL zoning overlay district where the only viable location for a stormwater storage basin requires blasting

This full waiver only applies to those portions of property meeting one of these three requirements.

100-year/2-hour storage is allowed, but not required for redevelopment projects and development within the ESL zoning overlay. Rather, these projects must store enough stormwater to attenuate post-development flows to predevelopment levels, considering the 10- and 100-year storm events (S.R.C. Sections 37-50 and 37-51).

By signing below, I certify that the stated project meets the waiver criteria selected above as demonstrated by the attached documentation.

[signature] 02/18/20

Stormwater Management Department

7447 E Indian School Road, Suite 125, Scottsdale, AZ 85251 • Phone: 480-312-2500

43-DR-2019
03/17/20

Request for Stormwater Storage Waiver

CITY OF SCOTTSDALE

City of Scottsdale Plan/Case Numbers:

43 - DR - 2019 ____ - PP - ____ PC#________

CITY STAFF TO COMPLETE THIS PAGE

Project Name Dear Valley Townhomes

Check Appropriate Boxes:

☐ Meets waiver criteria (specify): ☐ 1 ☐ 2 ☐ 3

Recommended Conditions of Waiver:

☐ All storage requirements waived.

☐ Post-development peak discharge rates do not exceed pre-development conditions.

☐ Other:

Explain: ____

____

☐ **Waiver approved per above conditions.**

______________________________ ______________________________

Floodplain Administrator or Designee Date

Stormwater Management Department

7447 E Indian School Road, Suite 125, Scottsdale, AZ 85251 • Phone: 480-312-2500

43-DR-2019
03/17/20

Request for Stormwater Storage Waiver

CITY OF SCOTTSDALE

City of Scottsdale Plan/Case Numbers:

43 - DR - 2019 ____ - PP - ____ PC#________

In-Lieu Fee and In-Kind Contributions

In-lieu fees are only applicable to projects where post-development peak discharge rates exceed pre-development levels, based on the 10- and 100-year storm events. If the city grants a waiver, the developer is required to calculate and contribute an in-lieu fee based on what it would cost the city to provide a storage basin, sized as described below, including costs such as land acquisition, construction, landscaping, design, construction management, and maintenance over a 75-year design life. The fee for this cost is $3.00 per cubic foot of stormwater storage for a virtual storage basin designed to mitigate the increase in runoff associated with the 100-year/2-hour storm event. The applicant may submit site-specific in-lieu fee calculations subject to the Floodplain Administrator's approval.

The Floodplain Administrator considers in-kind contributions on a case-by-case basis. An in-kind contribution can serve as part of or instead of the calculated in-lieu fee. In-kind contributions must be stormwater-related and must constitute a public benefit. In-lieu fees and in-kind contributions are subject to the approval of the Floodplain Administrator or designee.

Project Name Dear Valley Townhomes

The waived stormwater storage volume is calculated using a simplified approach as follows:

$V = \Delta CRA$; where
V = stormwater storage volume required, in cubic feet,
ΔC = increase in weighted average runoff coefficient over disturbed area ($C_{post} - C_{pre}$),
R = 100-year/2-hour precipitation depth, in feet (DSPM, Appendix 4-1D, page 11), and
A = area of disturbed ground, in square feet

Furthermore,

$V_w = V - V_p$; where
V_w = volume waived,
V = volume required, and
V_p = volume provided

R = 2.37 (NOAA)
ΔC = 0.5
A = 29,597
V = 2,923
V_p = 1,352
V_w = 1,571

☑ An in-lieu fee will be paid, based on the following calculations and supporting documentation:
In-lieu fee ($) = V_w (cu. ft.) x $3.00 per cubic foot = $4,713

☐ An in-kind contribution will be made, as follows:

☐ No in-lieu fee is required. Reason:

Approved by:

Floodplain Administrator or Designee ____________ Date ____________

Stormwater Management Department

7447 E Indian School Road, Suite 125, Scottsdale, AZ 85251 • Phone: 480-312-2500

Registered Professional Engineer (Civil)
CERTIFICATE NO.
42752
ROBERT O.
LYONS
Date Signed 11-20-19
ARIZONA, U. S. A.

Memorandum

DATE: November 20, 2019
TO: Lisa Nelson, P.E.
FROM: Rob Lyons, P.E., CFM
RE: **Riprap Revetment Analysis for Deer Valley Townhomes**

INTRODUCTION

This memorandum summarizes the hydrology & hydraulics, scour analysis, and riprap revetment requirements for the proposed Deer Valley Townhomes along an existing drainage channel in the City of Scottsdale. The Townhome site is located on the northwest corner of E. Deer Valley Rd & N. Miller Rd. as shown on Figure 1. The Townhomes will be elevated above the 100-year floodplain and protected from erosion and lateral migration from the channel as required by the City of Scottsdale.

HYDROLOGY

The most recent comprehensive hydrologic study recognized by the City of Scottsdale that covers the site is the Pinnacle Peak West (PPW) Area Drainage Master Study (ADMS)[1] conducted for the Flood Control District of Maricopa County (FCDMC). Detailed FLO-2D modeling was developed for a large area in north Scottsdale and includes the tributary area to the subject drainage channel. It is understood that the City of Scottsdale is recommending the use of the ADMS FLO-2D model results as the best available hydrology for offsite drainage design and for other purposes. The PPW FLO-2D sub-model that covers the Townhome Site is the Lower Rawhide Model (named for Rawhide Wash).

One of the limitations of the PPW Lower Rawhide FLO-2D model is that it receives inflows from the Pinnacle Peak South (PPS) ADMS[2] FLO-2D model. Figure 2 depicts the model boundaries of the tributary PPW and PPS studies. Outflow from the PPS model was extracted and used as inflow to the PPW models at every corresponding, external boundary FLO-2D grid element as shown in Figure 2. The PPS FLO-2D model executable used was found to have a significant error in which almost no infiltration occurred resulting in significant over prediction of runoff volumes and peak flow rates. The PPW project team agreed to use the inflow hydrographs from PPW nevertheless because of the effort that would be required to convert the model and use a newer executable without the error.

JE Fuller is currently under contract with FCDMC for the Rawhide Wash Flood Hazard Mitigation Final Design. This project includes fortifying existing floodwalls and construction of new walls along Rawhide Wash between Pinnacle Peak Road and several hundred feet north of Happy Valley Road. A Conditional Letter of Map Revision (CLOMR) is part of the contract and will ultimately result in a modification of the Rawhide Wash Effective Floodplain. A new, more robust and accurate FLO-2D model has been developed that includes the entire watershed tributary to Rawhide Wash and the large distributary area downstream of Scottsdale Road. The model results and model boundary are shown in Figure 3. This model covers the entire tributary area to the drainage channel adjacent to the Deer Valley Townhomes and used detailed design level topography for a significant portion of the area tributary to the Deer Valley Townhomes site. The Design Rawhide CLOMR model is considered the best available hydrology for this project.

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[1] 2014, JE Fuller, Pinnacle Peak West Area Drainage Master Study
[2] 2012, TY Lin, Pinnacle Peak South Area Drainage Master Study – Hydrology & Hydraulics Report – Volume 1, DRAFT

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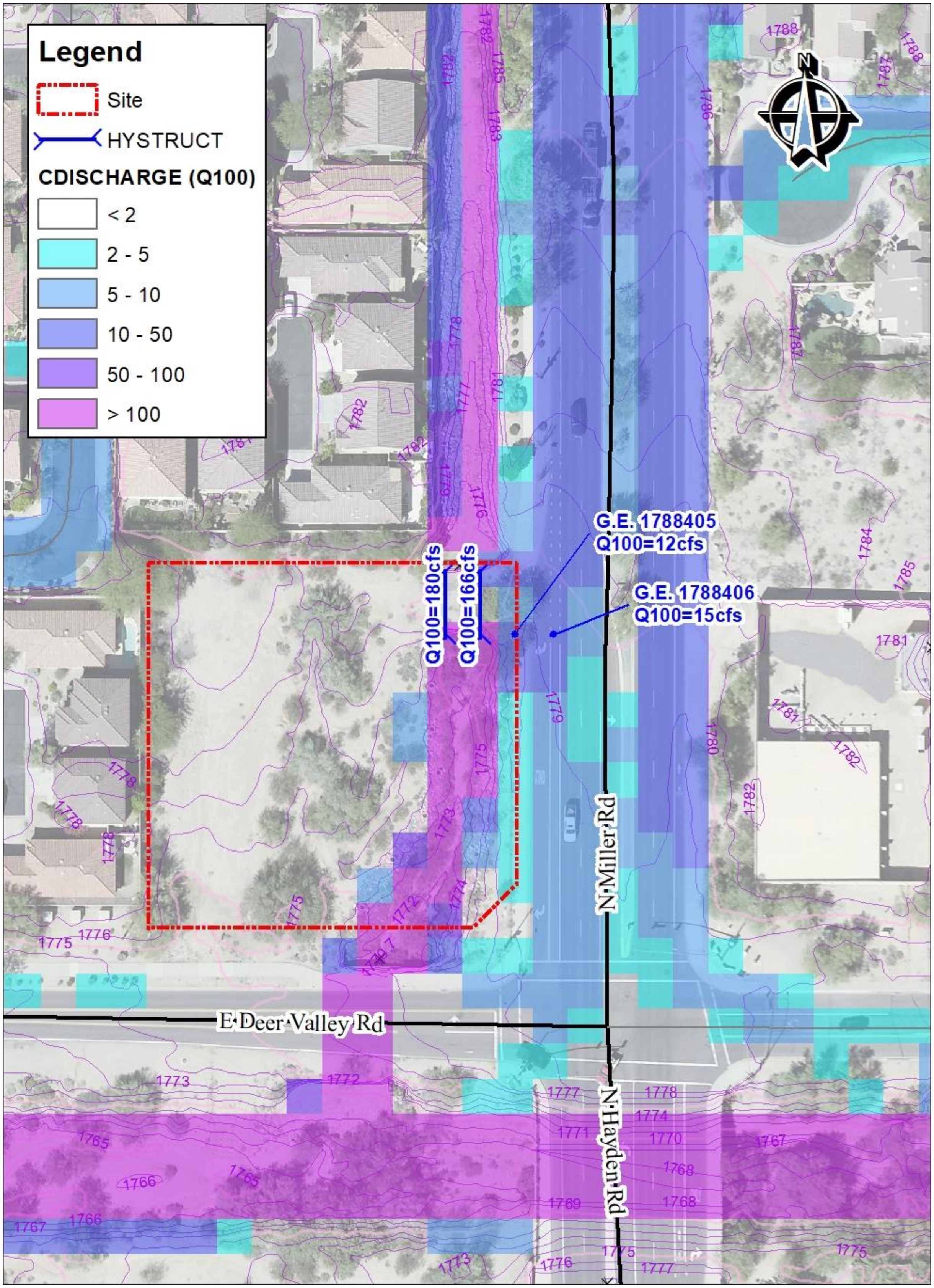

Figure 1. Deer Valley Townhomes Site Map and Rawhide CLOMR FLO-2D 100-Year Discharge Estimates

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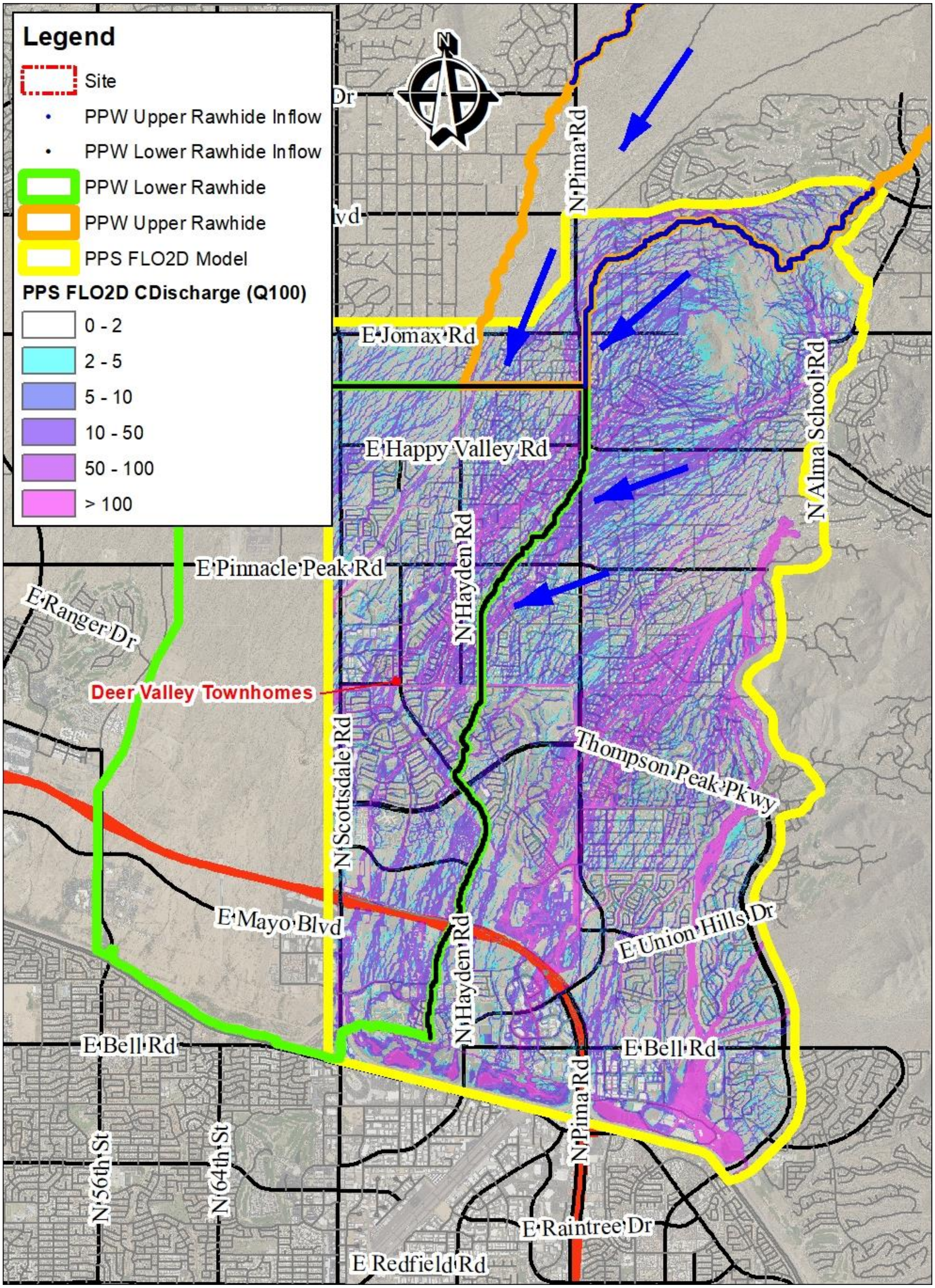

Figure 2. PPW and PPS ADMS FLO-2D Model Boundaries and Inflow Schematic

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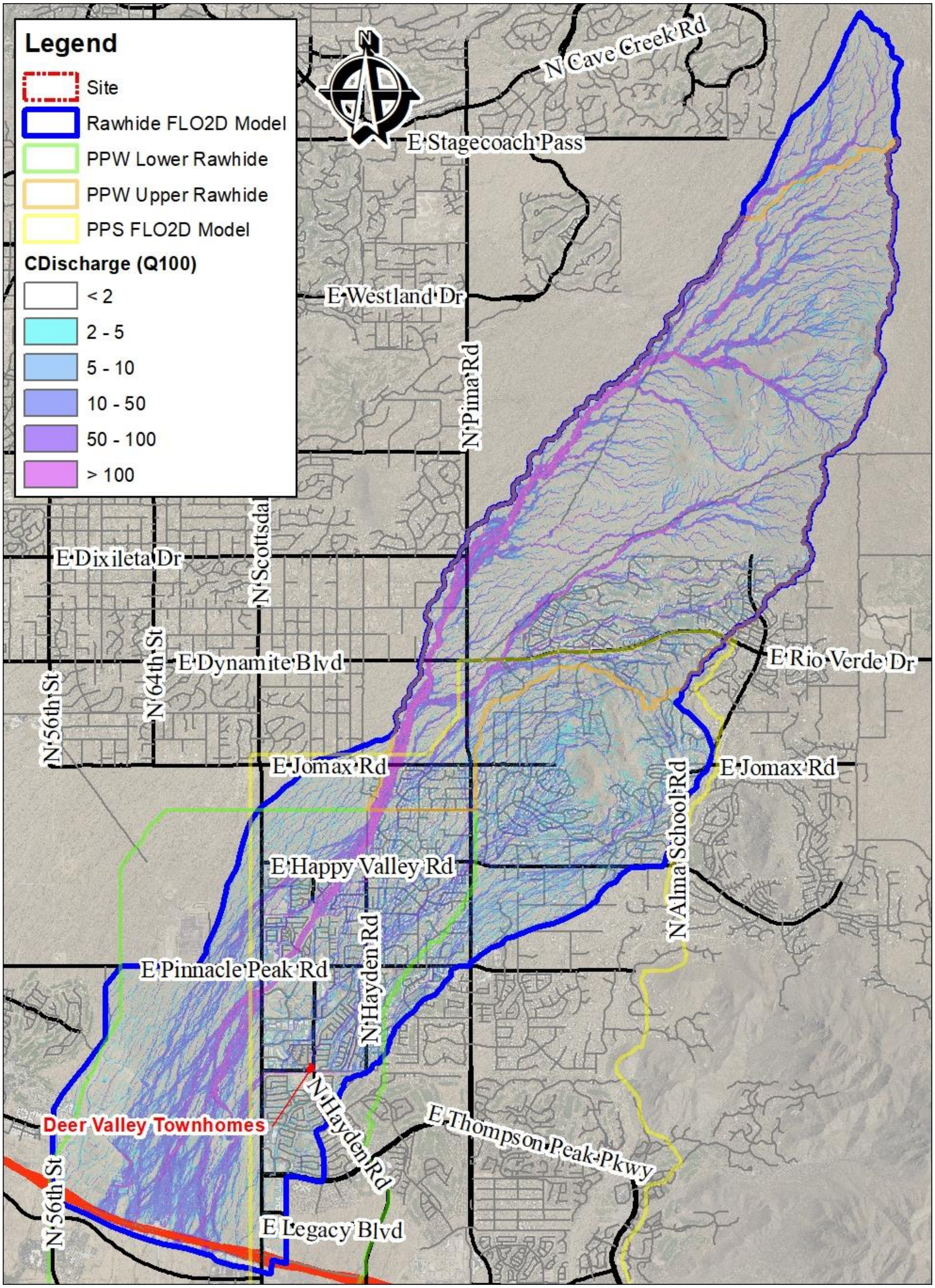

Figure 3. Rawhide Wash Flood Hazard Mitigation Final Design CLOMR Model Boundary and Results

The draft Rawhide CLOMR[3] is currently under review by FCDMC and the City of Scottsdale (see reference credentials below). The CLOMR package will be sent to FEMA when the 60% construction plans are complete which is expected to be in the Spring of 2020. The discharge for the drainage channel adjacent to the Deer Valley Townhomes site was estimated using the existing conditions, 100-year, 24-hour FLO-2D model from the Design Rawhide CLOMR. The discharge was computed by adding the peak flow rates through the existing 4-8x4 Arch culverts (represented by two hydraulic structures or FLO-2D HYSTRUCT.DAT ratings) and the peak discharge at two adjacent grid elements to the east as shown in Figure 1. This combined discharge is 373 cfs and is considered conservative. It is understood that the City of Scottsdale recommends design engineers to use a safety factor of 1.3 when using regional FLO-2D models. The design discharge for the drainage channel will be 485 cfs after applying this safety factor.

Scottsdale Review Submittal Credentials
Plan Check: 6443-19
Plan Type: IMPROVEMENT PLANS
Project Name: Rawhide Wash Flood Hazard Mitigation - Final Design
Address/Intersection: E HAPPY VALLEY RD / N HAYDEN RD
Key Code: 3083D

HYDRAULICS

JE Fuller used a HEC-RAS model prepared by Terrascape for the drainage channel that was developed using a recent topographic survey conducted for the site development and as-built survey information for the existing culverts on the site and across Deer Valley Road. The model was run in the mixed flow regime to obtain the hydraulic input needed for the scour and riprap analysis for erosion protection. The HEC-RAS model is documented in the Drainage Report prepared by Terrascape for the project.

RIPRAP REVETMENT ANALYSIS

The existing channel is currently lined with riprap, however, no As-Built drawings were found during a research effort conducted by Terrascape. Both the side slopes and channel bottom are lined with riprap; however, sediment has accumulated in the channel bottom covering the riprap. It is estimated that the riprap layer is buried beneath approximately 12-inches of sediment. This conclusion is based on the following:

1. A test hole was dug in the middle of the channel and large riprap elements were confirmed to be in place. Figure 4 depicts the location of the test hole. Photo 1 depicts the excavated hole and manually exposed riprap.
2. Several riprap elements are exposed above the sediment layer throughout the channel. Photo 2 depicts one example with a partial manual exposure of about 1-foot. Other riprap elements surrounding the exposed rock could be felt with strikes from the shovel
3. Historic aerial photos were reviewed on the FCDMC website[4]. It appears the riprap lined channel was constructed between 1996 and 1998. Riprap is observed in the channel bottom in the historic aerial photos from 1998 to 2006. Sediment deposition is observed in the aerials starting at year 2007. The riprap in the channel bottom appears to be mostly covered in sediment by year 2010.

[3] September 2019, JE Fuller, Rawhide Wash Flood Hazard Mitigation Conditional Letter of Map Revision
[4] https://gis.maricopa.gov/GIO/HistoricalAerial/index.html

4. The existing channel side slopes have a slope of approximately 4-5H:1V with an average channel bottom width of 15-feet. With this geometry, the extents of a standard riprap layer on each side of the channel would be connected within about 2-feet or less of toe-down depth, making a fully lined channel by default.

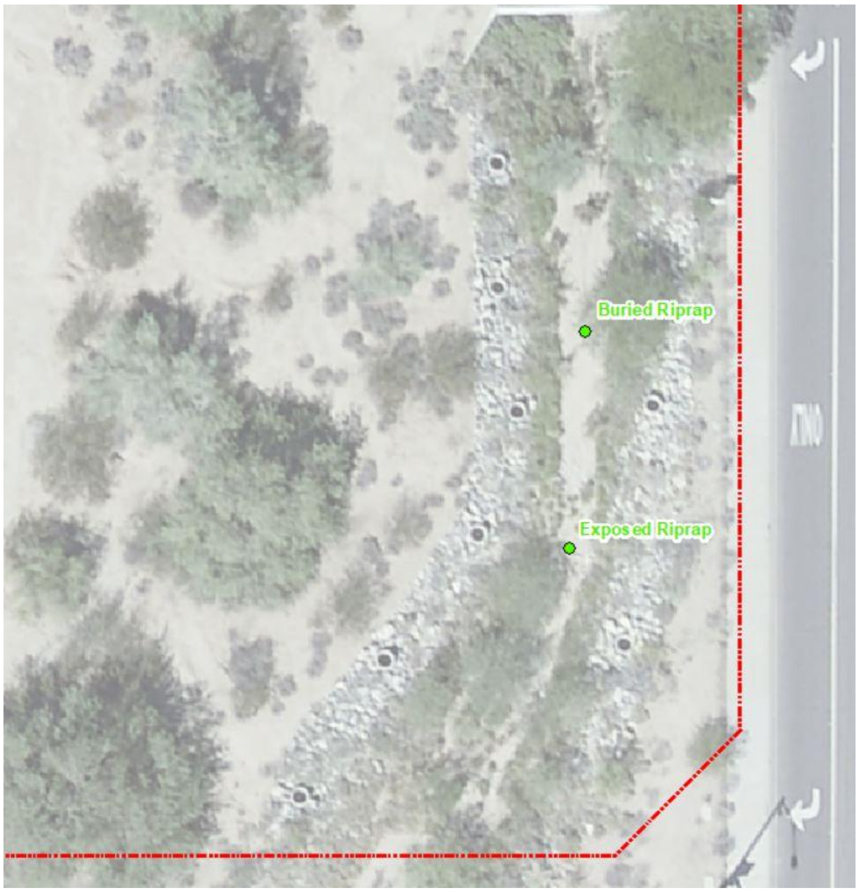

Figure 4. Test Hole Locations

Photo 1: Buried Riprap (Exposed) in Test Hole

Photo 2: Exposed Riprap Example

A Geotechnical investigation[5] was conducted for the project. The scope for the investigation was to verify the geometry and configuration of the existing riprap. The investigations resulted in the findings of a riprap layer thickness of approximately 16-20-inches with a D_{50} of approximately 20-inches with a filter fabric underlayment. It is understood that the sample was limited to rocks 30-inches and less. However, there are numerous riprap elements much larger than 30-inches. It should be noted that there are several 36" diameter concrete cylinders within the side slopes of the channel at a spacing of approximately 35-feet. The depths of these cylinders were measured and are founded below the riprap layer. It is not expected that these cylinders will decrease the stability of the riprap layer. It is assumed that these were originally installed to accomodate trees along the banks.

Therefore, riprap sizing calculations have been performed to confirm that the existing riprap is sufficient to meet current standards for preventing bed and lateral erosion. The required riprap size analysis was based on the FCDMC Hydraulics Manual's[6] recommended Isbash equation (equation 6.33) which results in a median stone size or D_{50} of 10.5-inches. The minimum riprap layer thickness will be 1.5 times the D_{50} or 16-inches. The hydraulic data used in the Isbash equation was based on the HEC-RAS model previously discussed run in the mixed flow regime. Calculations are enclosed. Given the existing riprap layer is at least 16" thick, the channel lining is deemed more than sufficient to protect the channel from bed and lateral erosion.

SCOUR ANALYSIS

Since the existing channel is currently adequately lined with riprap, scour analysis is unnecessary as scour should not occur. Nevertheless, a scour analysis was performed in case the developer of the property is interested in replacing the riprap or to modify the channel geometry.

The scour analysis has been conducted following procedures outlined in the FCDMC manual. Hydraulic data needed for the scour analysis was taken from the HEC-RAS model previously discussed. The scour analysis for the total scour depth includes the following scour components:

1) Bedform Scour
2) General Scour
3) Long-term Scour
4) Low-Flow Incisement Scour

Each scour component is discussed independently below.

<u>Bedform Scour</u>

Bedform scour calculations quantify the change in bed elevation created by the formation of dunes and anti-dunes during a specific flow event. Bedform scour has been calculated with the methodology that is outlined in the chapter 11 of the FCDMC Hydraulics Manual. Results from the HEC-RAS model run in the mixed flow regime were used for these calculations. The resulting Bedform Scour computed is 1.1 feet.

<u>General Scour</u>

General scour involves the removal of material from the bed and banks during design event, the 100-year flood in this

[5] October 21, 2019, Memorandum Re: Geotechnical Engineering Services Deer Valley Townhomes – Riprap Study NWC of Deer Valley Road and Miller Road Scottsdale, AZ, SAECO Project No. 44.19.2158, SAECO

[6] 2018, FCDMC, Drainage Design Manual for Maricopa County: Hydraulics

Case, which will result in the most conservative estimate. General scour has been calculated with the Lacey Equation as outlined in the chapter 11 of the FCDMC Hydraulics Manual. There was no sieve analysis (grain size distribution) for the bed or underlying bank material sediment sampling available. A small sample of the material was collected for visual inspection. The Geotechnical investigation described previously and the Geotechnical Engineer noted that the wash sediment consisted of course to fine sediment deposits. Photo 3 below depicts the channel sediment which confirms a sandy gravel. Sandy to fine gravel material can range from 1 to 5 millimeters.

Photo 3. Drainage Channel Photo upstream of existing culverts at northeast corner of Site

Several sediment samples were tested with a Sieve Analysis and Grain Size Distribution[7] for the follow-on work for the PPW ADMS project for Rawhide Wash. These samples resulted in a mean grain size of D50=1.84 mm which will be used for the wash on the Townhomes site analysis. A qualitative comparison of the small sediment sample collected for this project appears to have a larger mean grain size, more like 3 mm. Therefore, the use of D50=1.84 mm should yield a conservative General Scour depth for this watercourse. The resulting General Scour computed is 0.7 feet. These results seem reasonable, particularly because the Lacey equation is not that sensitive to the various D50 values within the same order of magnitude.

Long-term Scour

Long-term scour can be estimated using various method such as sediment transport modeling, equilibrium slopes, and historic profile comparisons. It is understood that the existing drainage channel was constructed between 1996 and 1998, approximately 20 years ago. Over these 20 years, the channel has obviously aggraded by approximately 1-foot

[7] 2016, JE Fuller, PPW ADMS – Rawhide Wash Alternatives Work Assignment No. 6, Phase II: Data Analysis, Sediment Transport Analysis (Task 3.1), Appendix A-8 Grain Size Distribution

as previously described. Therefore, long-term scour or degradation is not expected. Nevertheless, the Level 1 analysis from Arizona State Standard 5-96 was performed to estimate a conservative long-term scour (LTS) component. This simplistic analysis is only a function of the 100-year discharge where LTS = $0.2*Q_{100}^{0.6}$. With a Q100 = 485 cfs, the estimated long-term scour is 0.9-feet.

Low-Flow Incisement Scour

The Low-Flow Incisement Scour component accounts for a low-flow channel that occurs in unlined constructed channel bottoms. The FCDMC manual suggests assuming 1-ft if no other information is available.

Total Scour

The Total Scour estimated for the channel within the Deer Valley Townhomes site is the sum of the three scour components along with a Safety Factor as outlines below:

$Z_t = 1.3\ (Z_a + Z_{gs} + Z_{lts} + Z_{lf})$; where:

Z_t = Design scour depth
Z_a = Bedform Scour (Anti-dune trough depth) (ft)
Z_{gs} = General scour depth (ft)
Z_{lts} = Long-term scour depth (ft) or LTS
Z_{lf} = Low-Flow Incisement Scour
1.3 = Safety factor to account for non-uniform flow distribution

Therefore, the total scour estimated along the Deer Valley Townhomes Channel is 5.0-feet as summarized below:

$Z_t = 1.3\ (1.1 + 0.7 + 0.9 + 1.0) = 4.8$ feet → 5.0 feet

Individual scour calculation worksheets are enclosed.

CONCLUSION

The existing riprap is sufficient to protect development on Deer Valley Townhomes site against erosion from the estimated 100-year design flow rate.

ENCLOSURES

FCD-recommended Isbash Equation:

$$D_{50} = \frac{V^2}{2gC^2 \cos\varphi}\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right)$$

	Input	
V =	11.0523	
V_a =	8.31	
C =	1.2	Low Turbulence
g =	32.18	
γ_s =	165	default 165
γ_w =	62.2	
Slope (H:1)	3	enter 0 for channel bottom
φ =	0.32	

D_{50} =	0.84	ft
D_{50} =	10.09	in
Use	**10.5**	**in**

River Sta	Vel Total (fps)
723	3.57
660	5.96
600	10.66
558	4.34

Average = **8.31**

Definitions:

V = maximum velocity, V = 1.33 Va (Subramanya, 1997), (ft/s)
V_a = average velocity (ft/s)
C = coefficient (use 1.2 for low turbulence areas or 0.86 for high turbulence areas)
g = gravitational acceleration, (ft/s^2)
γ_s = specific weight of stone, (lb/ft^3)
γ_w = specific weight of water, (lb/ft^3)
Side Slope = bank side slope (H:V)
φ = bank angle, (radians)

D_{50} = median rock size, also defined as the diameter where 50% is finer by weight

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Bedform Scour - 100-year

Reach	River Sta	Profile	Q Total	Vel Total	Vel Chnl	Hydr Depth	Max Chl Dpth	Froude # Chl	Dune	AntiDune	Bedform
		Averages:		6.1	8.4	2.1	3.1	1.0	0.6	2.3	**1.1**
			(cfs)	(ft/s)	(ft/s)	(ft)	(ft)		(ft)	(ft)	(ft)
RAS River	723	PF 1	485	3.57	4.74	2.86	3.97	0.42	0.858	0.606625	0.429
RAS River	660	PF 1	485	5.96	10.61	2.14	3.7	1	0.642	3.039447	1.520
RAS River	600	PF 1	485	10.66	13.02	1.36	2.06	1.76	0.408	4.577051	2.289
RAS River	558	PF 1	485	4.34	5.41	1.94	2.63	0.63	0.582	0.790239	0.291

The anti-dune height equation (based on Kennedy, 1961) for upper regime flow where $F_r > 1.0$ is shown per Simons, Li & Associates, 1985, as:

$$d_h = 0.027V_a^2 \qquad (11.73)$$

where:

d_h = antidune height measured from mound top to trough bottom, ft;

V_a = average channel velocity, ft/s.

When $1.0 \geq F_r \geq 0.7$, the higher value between the dune height equation and anti-dune height equation should be used.

All equations from Chapter 11 of Flood Control District of Maricopa County Hydraulics Manual (2018)

Lacey Equation

The Lacey equation is more applicable to a natural river system (Blench, 1969) where there are no upstream structures that capture sediment:

$$Z_{general} = Z\left(0.47\left[\frac{Q}{f}\right]^{1/3}\right) \tag{11.56}$$

Zgeneral = $\boxed{0.7}$ ft for straight reach

Q =	485		Q/f =	203.1516
f =	1.76Dm^0.5	2.38738	Q/f^0.333	5.877552
Dm =	1.84 mm		*0.47	2.762449
Z =	0.25 straight reach		*Z	0.690612

All equations from Chapter 11 of Flood Control District of Maricopa County Hydraulics Manual (2018)

MEMORANDUM 1

October 21, 2019

Attention: Masuda Yasmin
Project Manager

Whitneybell Perry Inc
1102 East Missouri Avenue
Phoenix, Arizona 85014

RE: Geotechnical Engineering Services
Deer Valley Townhomes – Riprap Study
NWC of Deer Valley Road and Miller Road
Scottsdale, Arizona
SAECO Project No. 44.19.2158

PROJECT UNDERSTANDING

SAECO understands the scope of services for this project involves a geotechnical assessment to determine the existing rip-rap thickness and design gradation located within the City of Scottsdale (City) drainage easement. The existing drainage easement is located along the eastern limits of the project site. We understand the City does not have as-built information pertaining to the riprap placement and design gradation. We understand the City has requested to have this material evaluated as part of the proposed site development. Based on review of publicly available historical aerial photographs, the riprap was placed between the year 2000 and 2002.

FIELD ASSESSMENT

On October 16, 2019, SAECO performed the requested fieldwork to determine the riprap gradation, existing D_{50} size, and the thickness. Due to the size and weight of the particles, SAECO sized the riprap using ASTM D5519- Method D (Standard test method for particle size analysis of natural and man-made riprap materials). We partitioned an area (Figure A-1) that was approximately 1,340-square feet in size to determine the riprap gradation. Within the partitioned area, we sorted and measured approximately 160 particles. The particles measured ranged from passing a 30-inch sieve to retained on a 3-inch sieve. Approximately 15-percent of the particles measured would be considered flat and elongated (i.e., in excess of 3:1 ratio length to width).

The particle measurements were converted to weight, using the equations provided in the referenced ASTM standard to determine the riprap gradation. Based on our gradation analysis, the current riprap D_{50} size is approximately 20-inches.

The riprap was approximately 14- to 20-inches in thickness underlain by a geotextile. At some locations, the riprap was one particle thick with a few inches of fine sediment build-up around the base of the particle. The geotextile was exposed and ripped at discrete locations along the western bank. In addition to measuring the riprap thickness, SAECO performed one test pit using a Bobcat E26R compact excavator to determine the riprap construction. Figure A-2 depicts the approximate riprap construction encountered in our test pit.

SMITH & ANNALA ENGINEERING CO.
SAECO

We were also tasked with determining the extents of the riprap. We potholed along the wash bottom to determine if the riprap extended from bank to bank at four locations (denoted as TP-1 through TP-4, Figure A-1). At each pothole location, we encountered 12- to 16-inches of course to fine wash sediments deposited on the wash subgrade soils. In two of the potholes (TP-1 and TP-3), we encountered cobble size particles (potential riprap particles) that appeared to have been deposited from previous flow events. As such, we do not believe the riprap extended from bank to bank.

Based on our review of the historical Uniform Standard Specifications for Public Works Construction, Sponsored and Distributed by the Maricopa Association of Governments, published in 1998 and revised in 2002, it appears the riprap was constructed per the governing standard, in use at the time. Additionally, the riprap construction meets the physical properties outlined in 2019 revisions to the 2015 Uniform Standard Specifications for Public Works Construction.

SAECO appreciates the opportunity to provide this information. Please call should further information be required.

Sincerely,

Registered Professional Engineer
CERTIFICATE NO. (Civil)
60051
Daniel C
Rosenbalm
Date Signed 10-22-2019
ARIZONA U.S.A.
Expires 06-30-2021

Daniel C. Rosenbalm, Ph.D., P.E.
Geotechnical Services Manager

Bryan W. Reed, P.E.
Senior Geotechnical Engineer

Attachments:

- Figure A-1 Exploration Location
- Figure A-2 Riprap Cross-Section
- Riprap Gradation

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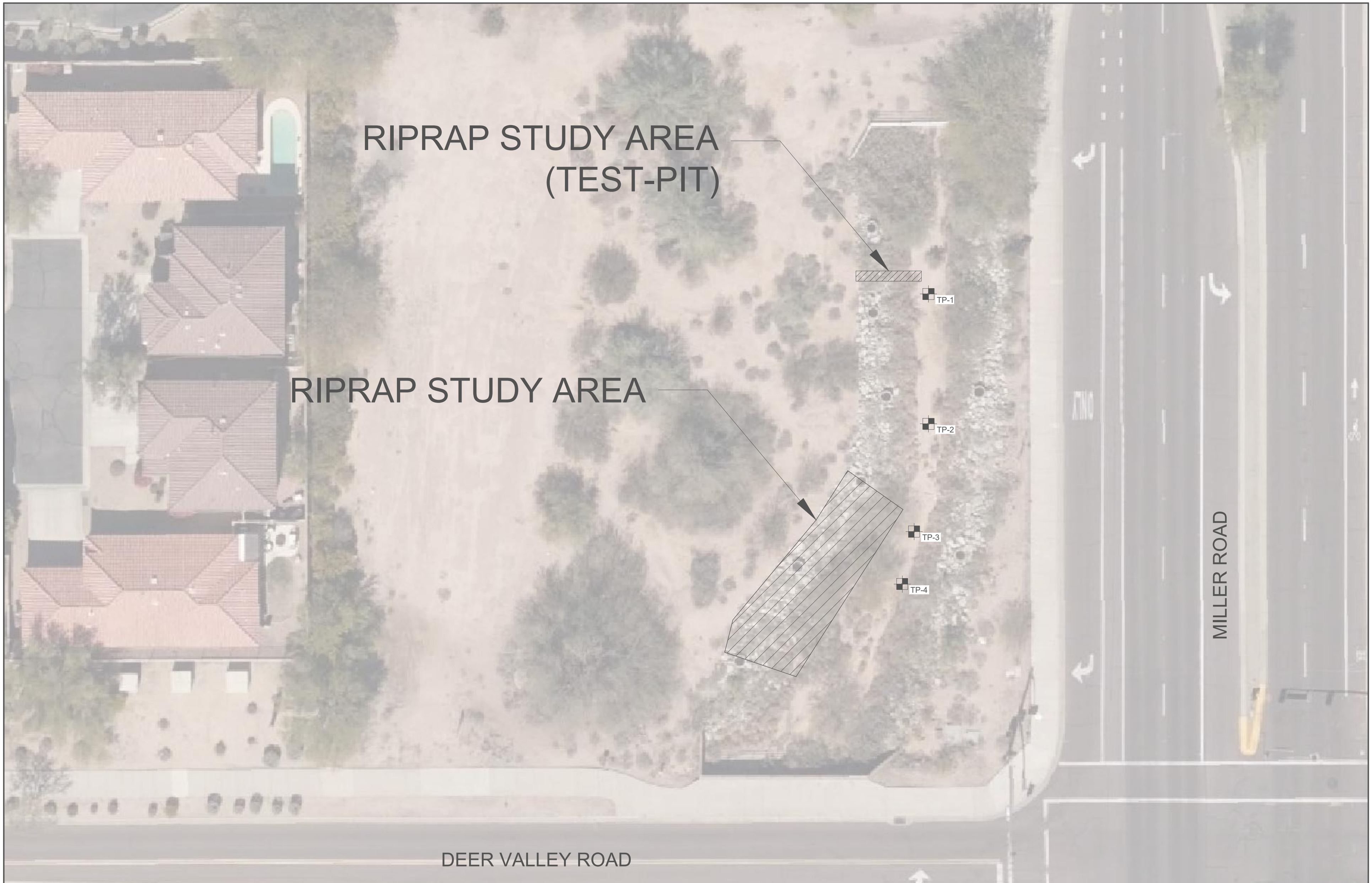
03/17/20



PROJECT MANAGER:	SCALE:
DCR	1"=40'
CHECKED BY: DCR	DATE: 10/2019
PROJECT NUMBER: 44.19.2158	

SMITH & ANNALA ENGINEERING CO.
SAECO
www.saecosafe.com

DEER VALLEY TOWNHOMES - RIPRAP STUDY

NWC OF DEER VALLEY ROAD AND MILLER ROAD
SCOTTSDALE, ARIZONA

0 INCHES 1
0 FEET 40

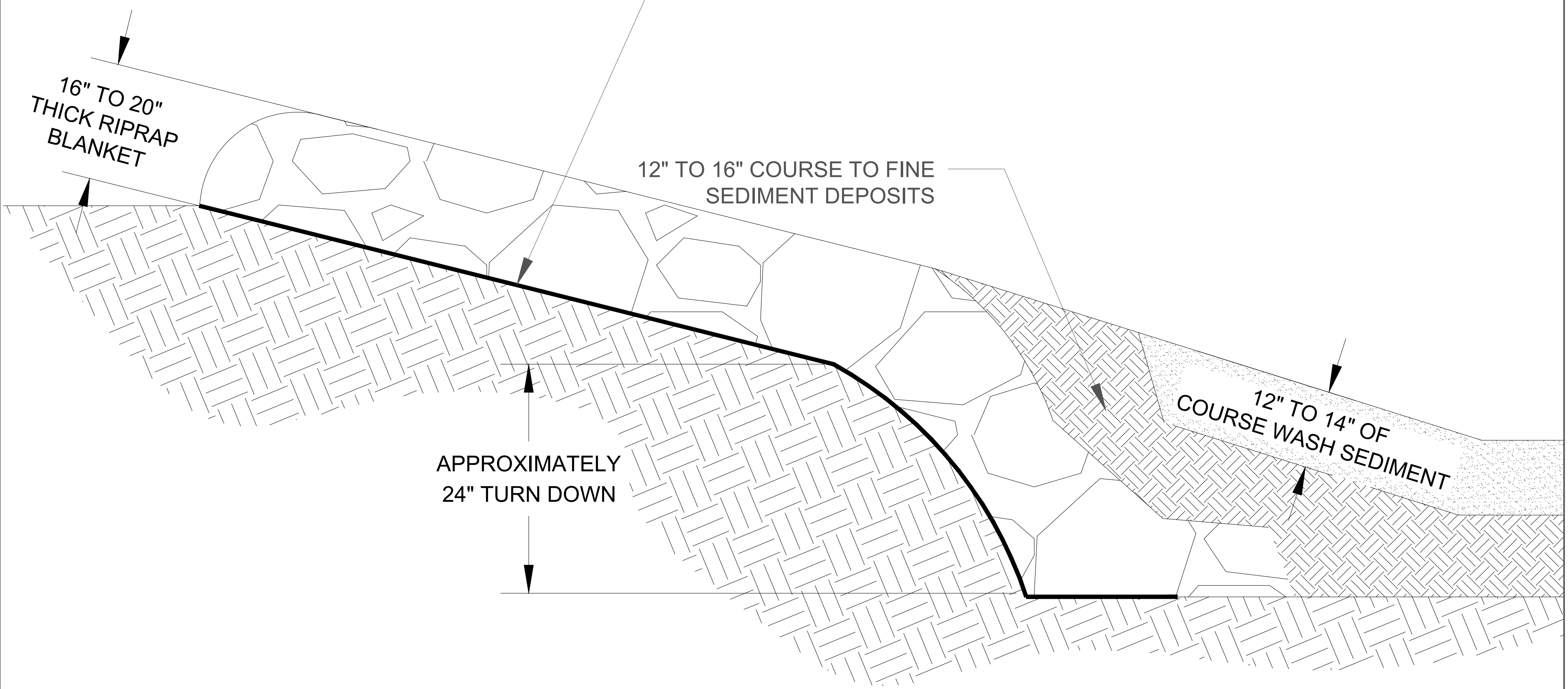
N

CLIENT: WHITENYBELL PERRY INC

FIGURE TITLE: EXPLORATION MAP

FIGURE NO.: A-1

43-DR-2019
03/17/20



PROJECT MANAGER:	SCALE:
DCR	NTS
CHECKED BY: DCR	DATE: 10/2019
PROJECT NUMBER: 44.19.2158	

SMITH & ANNALA ENGINEERING CO.
SAECO
www.saecosafe.com

DEER VALLEY TOWNHOMES - RIPRAP STUDY
NWC OF DEER VALLEY ROAD AND MILLER ROAD
SCOTTSDALE, ARIZONA

CLIENT:	FIGURE TITLE:	FIGURE NO.:
WHITENYBELL PERRY INC	RIPRAP CROSS-SECTION	A-2

43-DR-2019
03/17/20

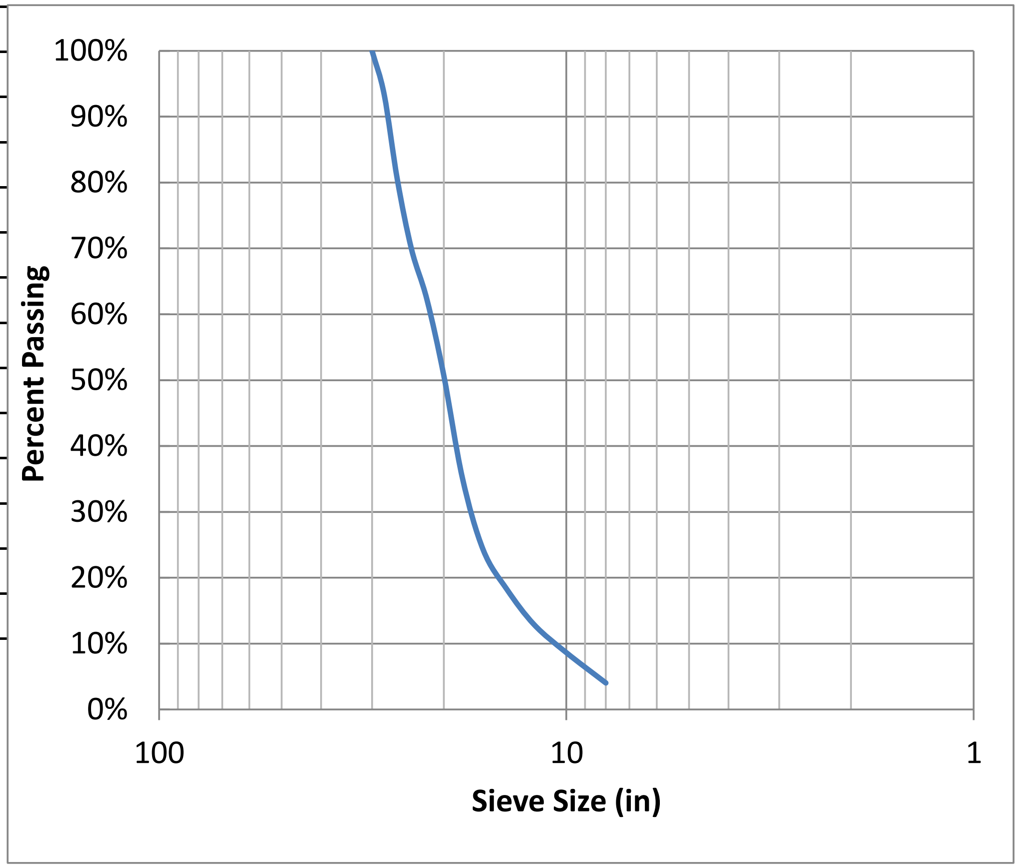
Laboratory Report

SMITH & ANNALA ENGINEERING CO. SAECO

Report Date: 10/22/2019
Client: Whitneybell Perry Inc
Project: Deer Valley Townhomes - Riprap Study
Project Location: Scottsdale, Arizona
Sample Location: See Exploration Figure, A-1

Date Sampled: 10/16/2019
Project Number: 44.19.2158
Material Type: D_{50}= 20-inch
Sampled By: DCR/ BM / MH
Tested BY: DCR/ BM / MH

Gradation - ASTM D 5519 - Method D	
Sieve Size	Percent Passing
30"	100%
28"	93%
26"	80%
24"	70%
22"	62%
20"	51%
18"	35%
16"	24%
14"	18%
12"	13%
10"	9%
8"	4%

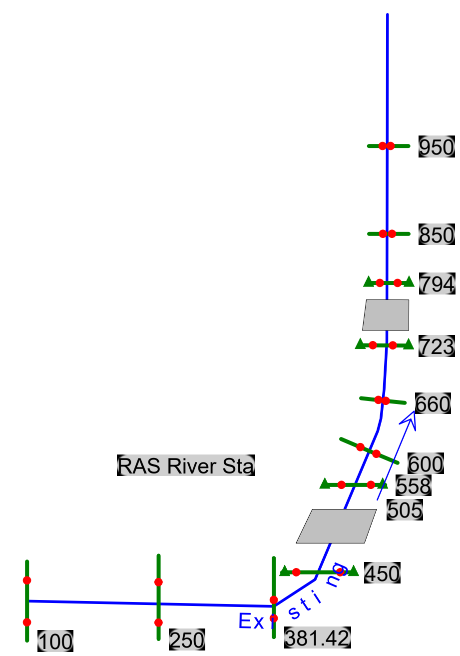


Comments:

Daniel C. Rosenbalm, Ph.D., P.E.
Geotechnical Services Manager

Appendix E

HEC-RAS Output



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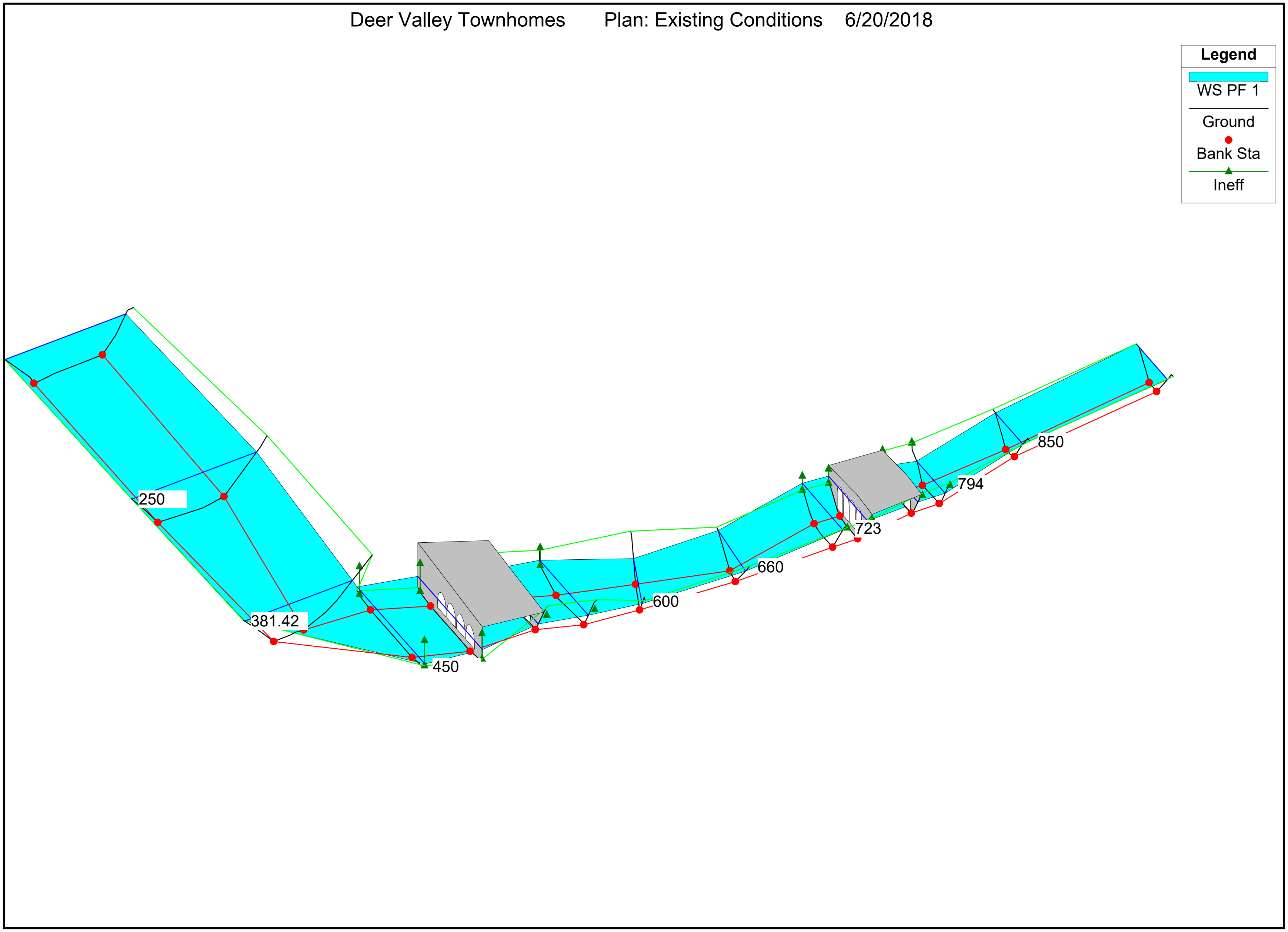

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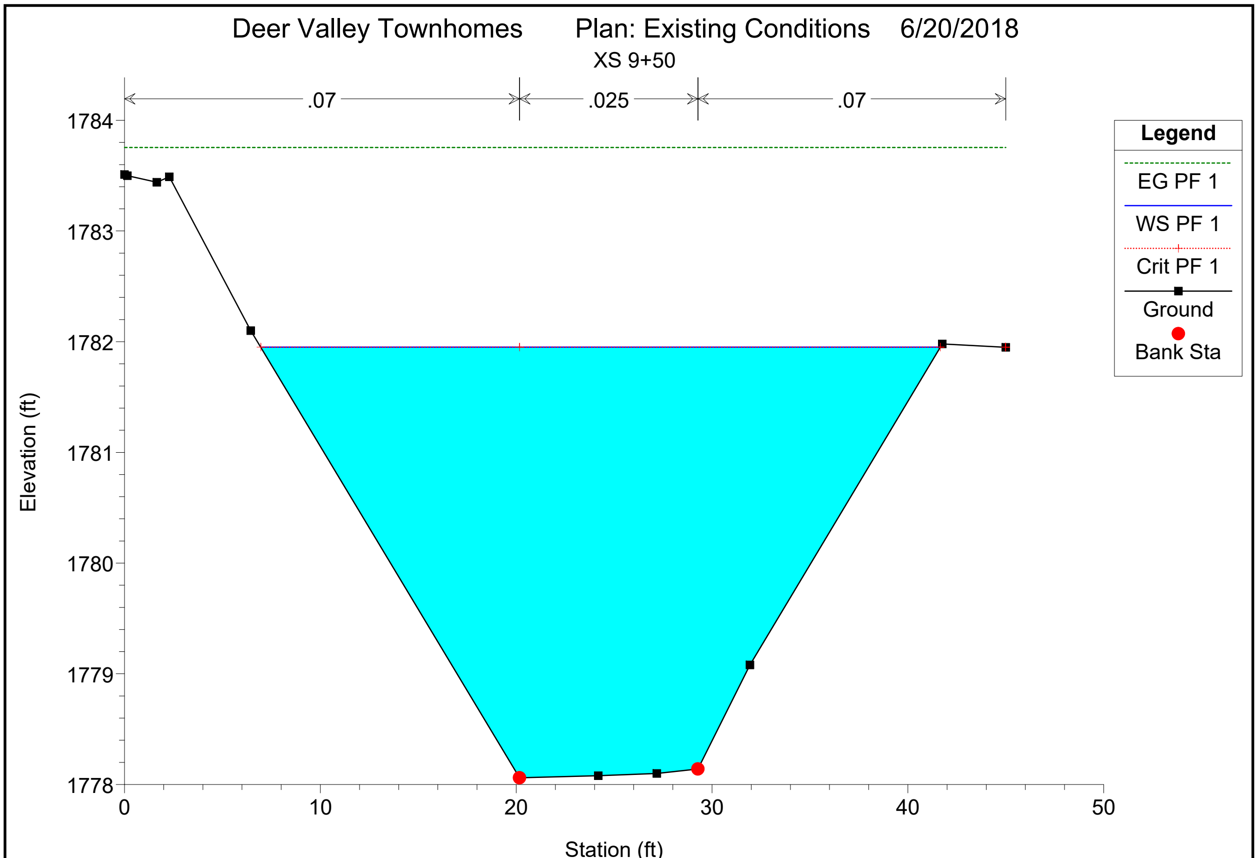
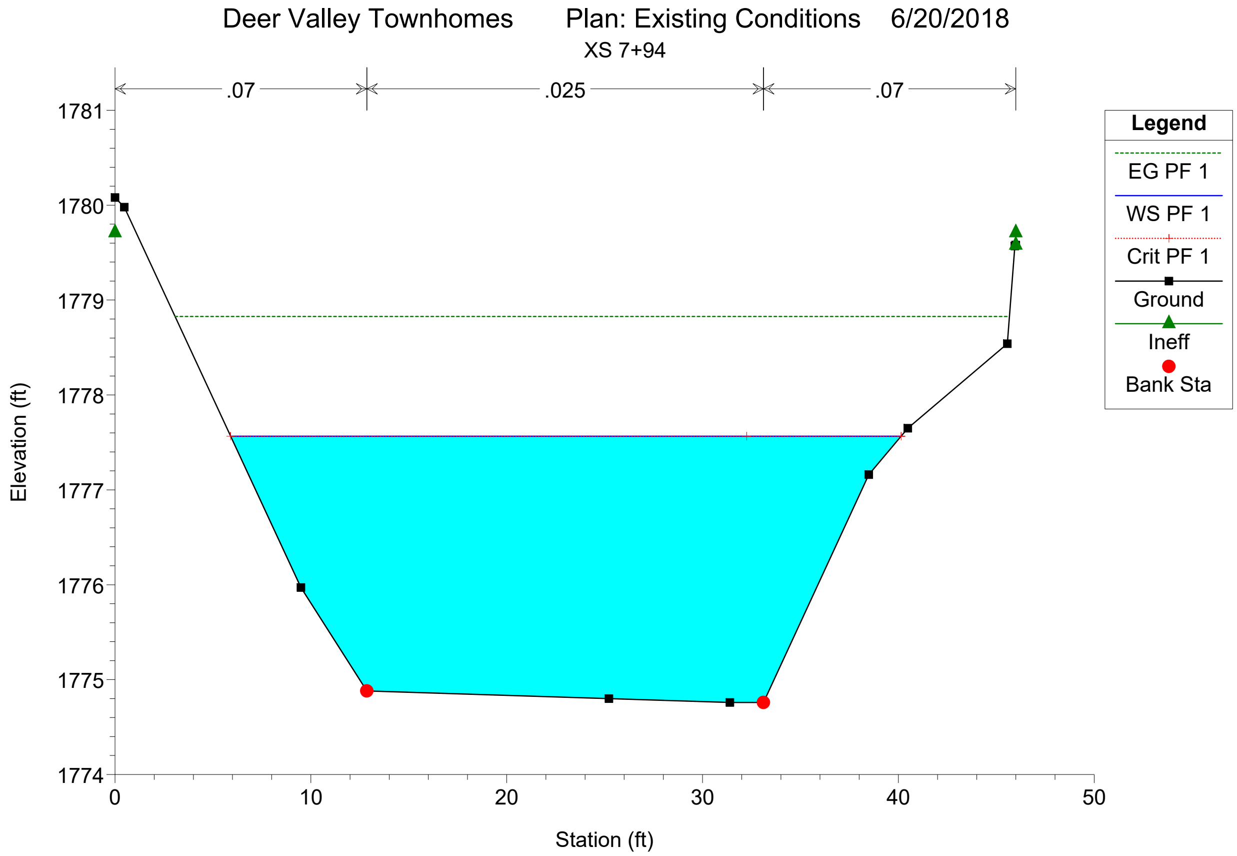
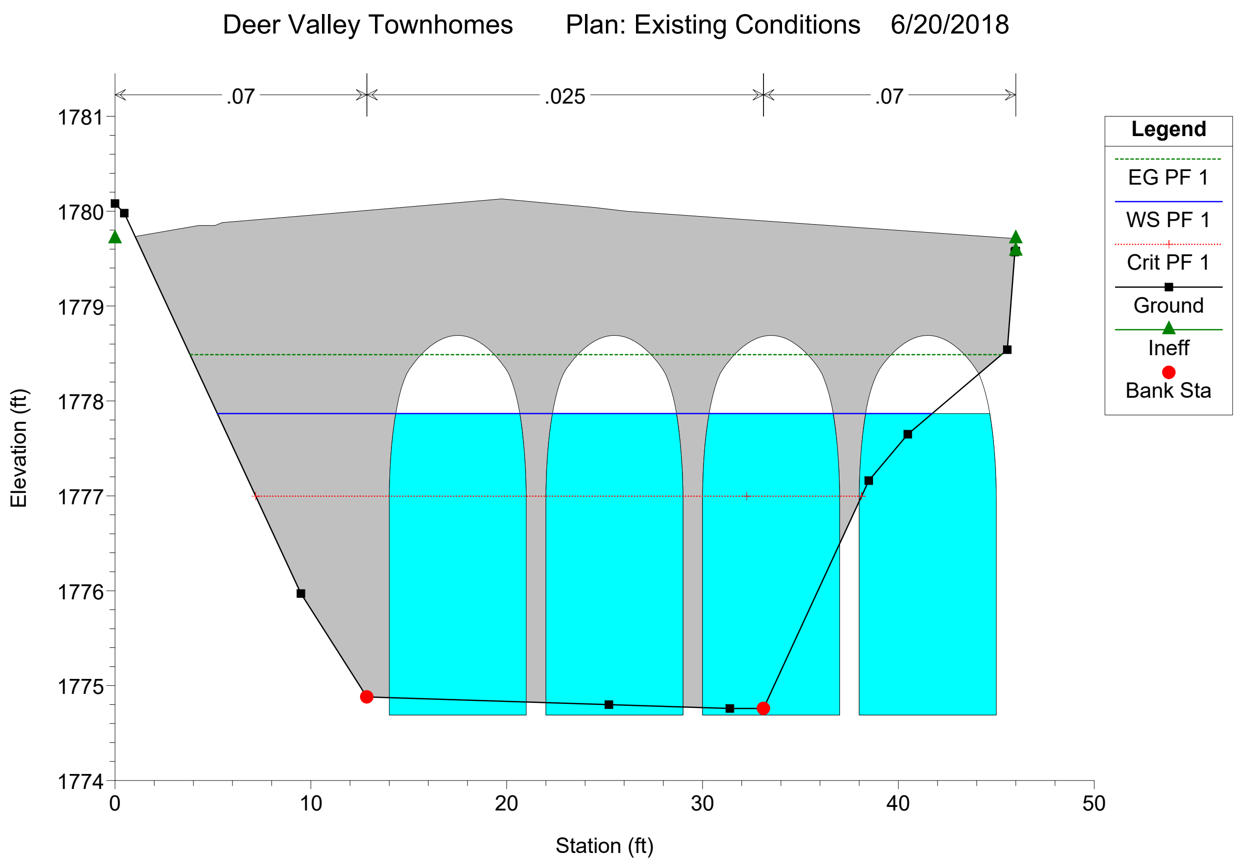


43-DR-2019
03/17/20





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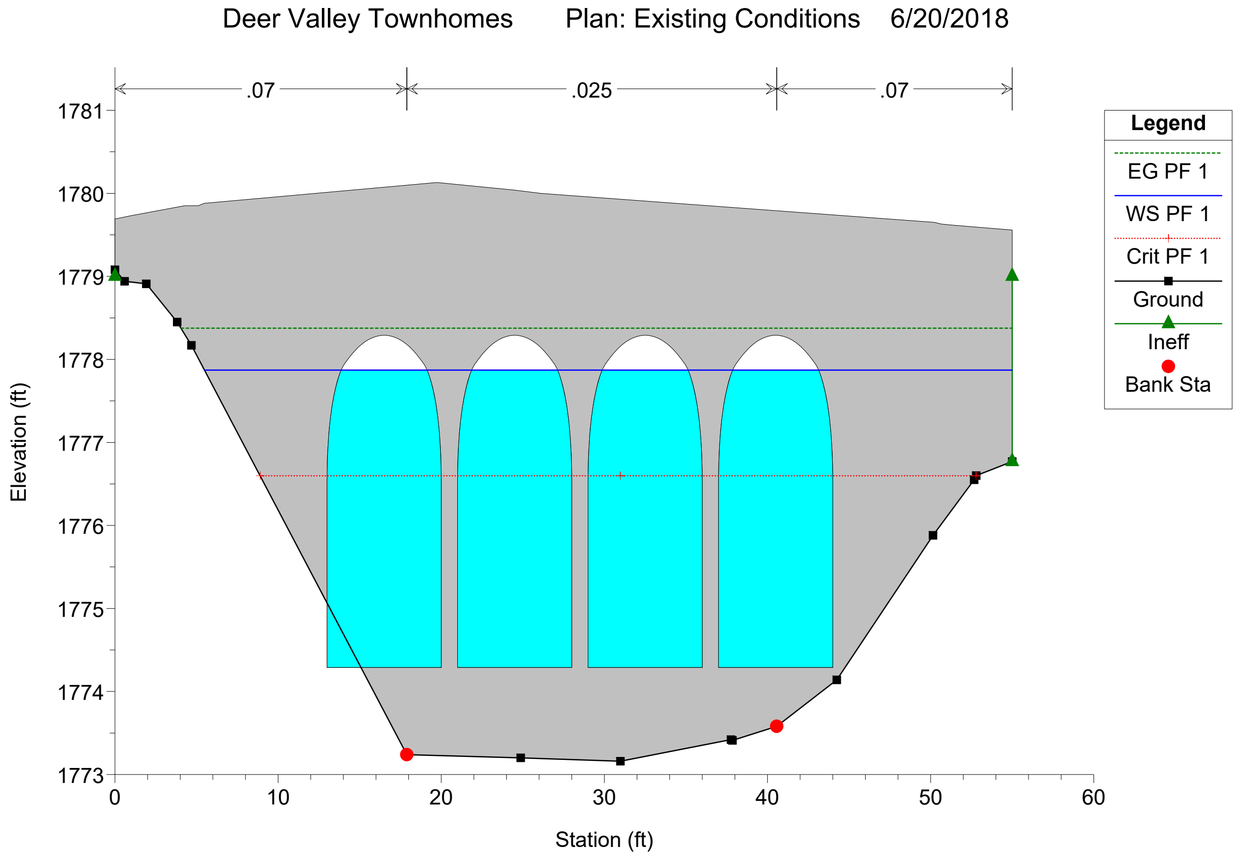

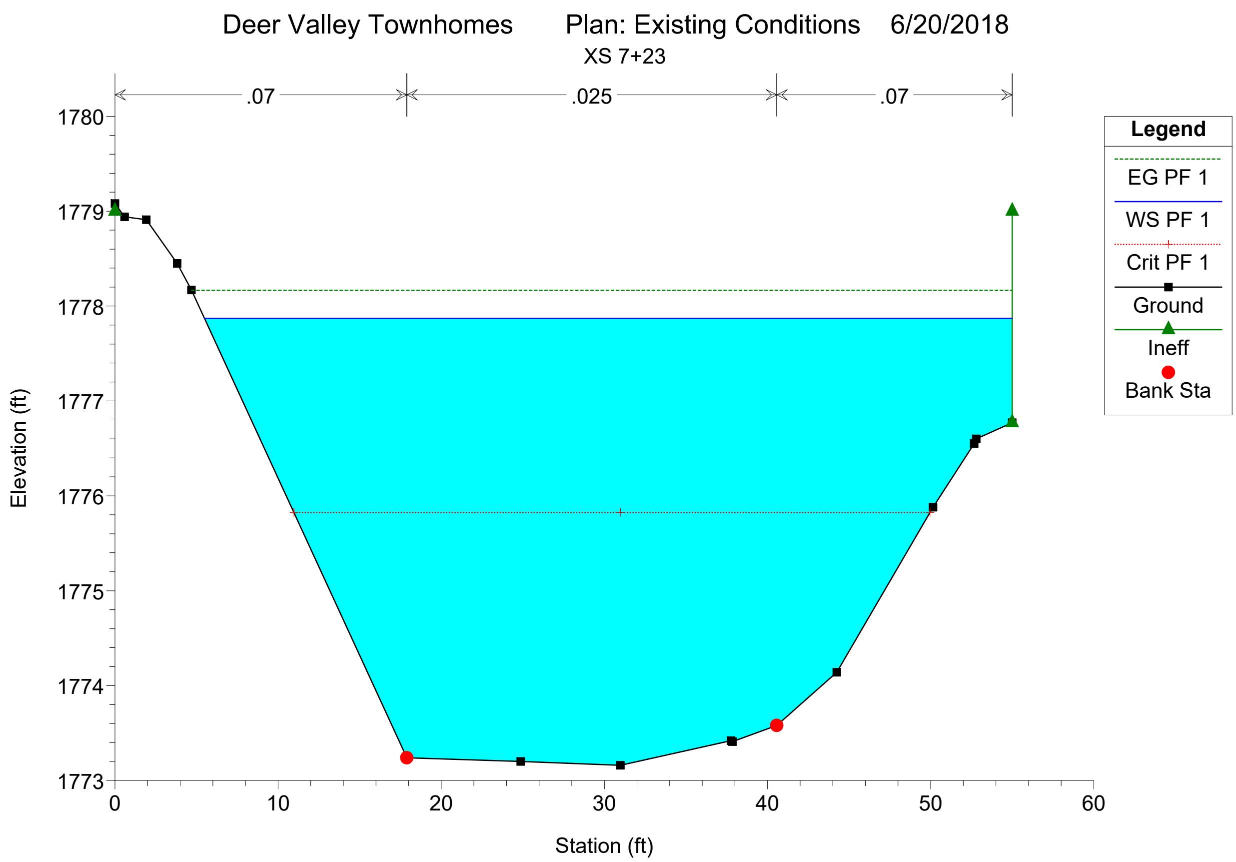

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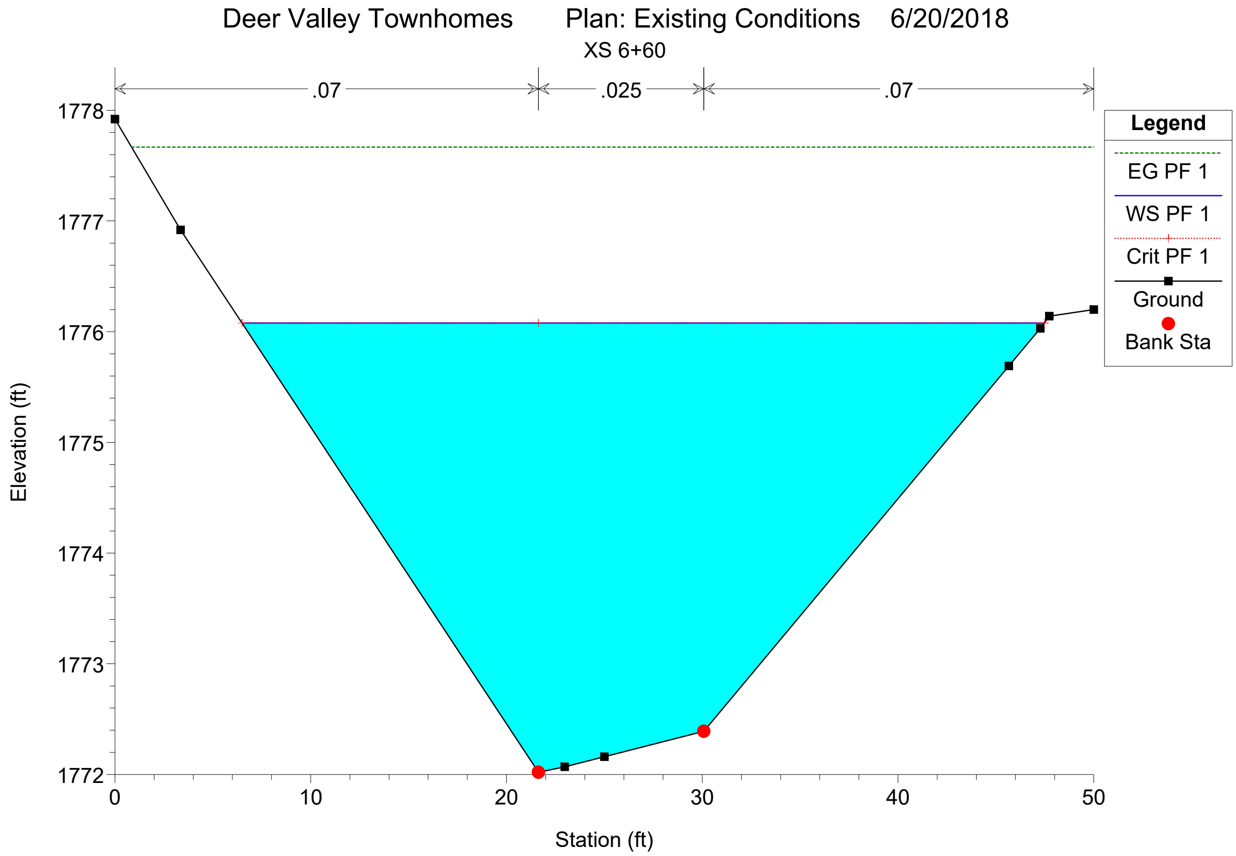

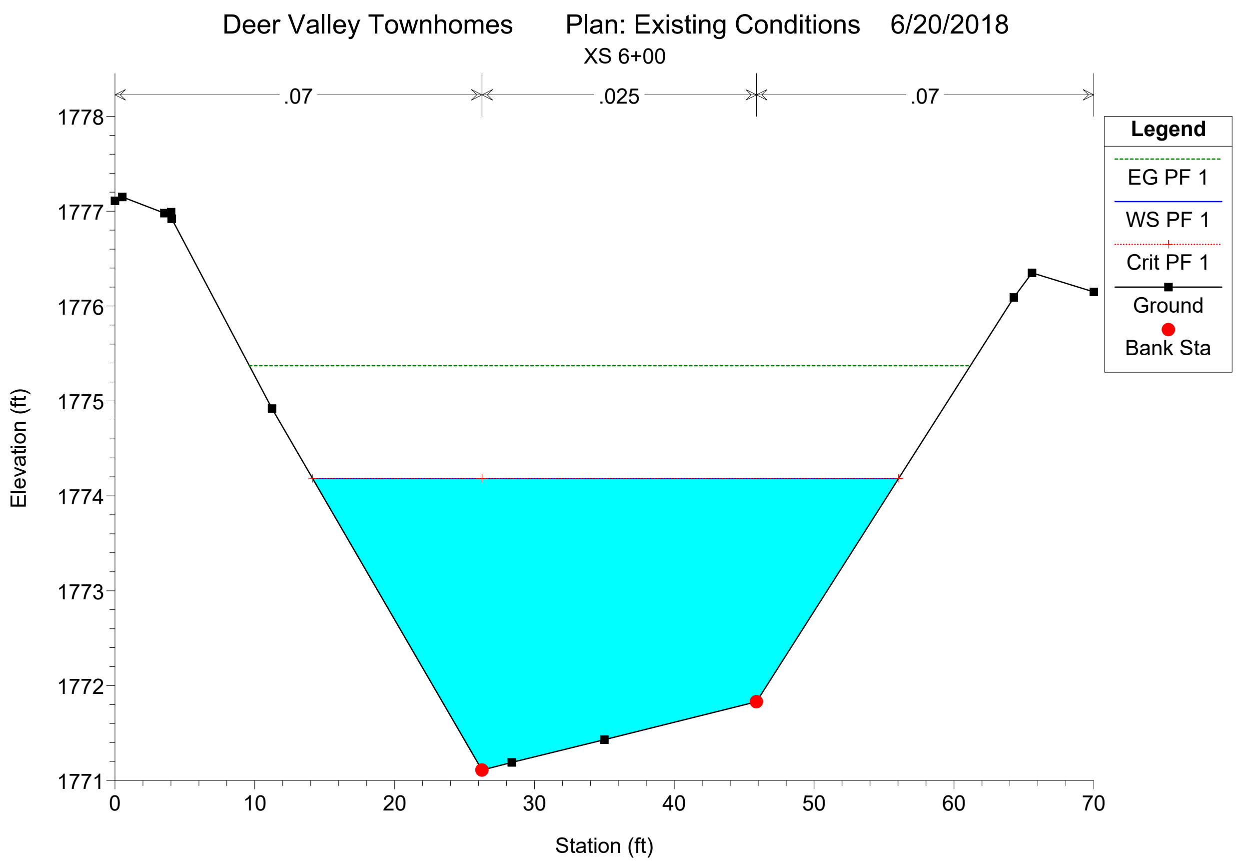

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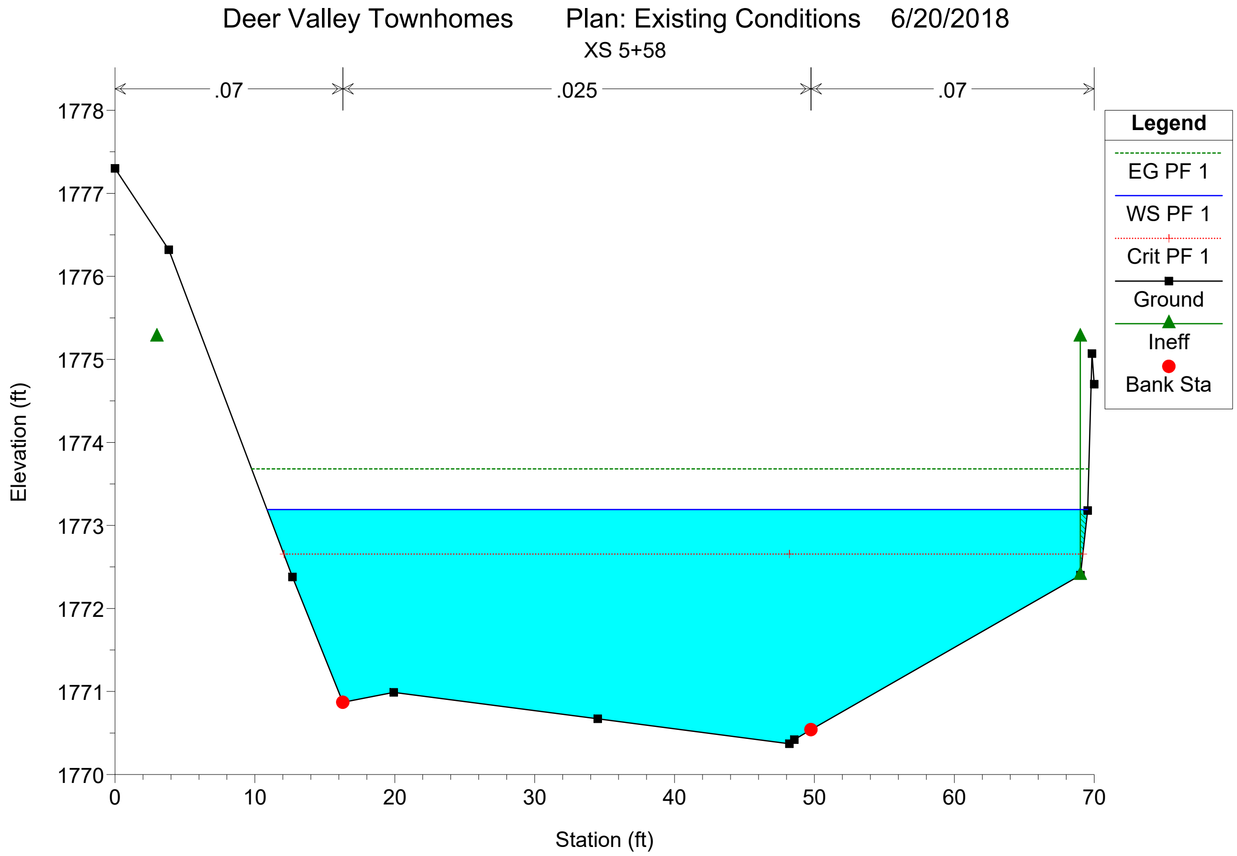

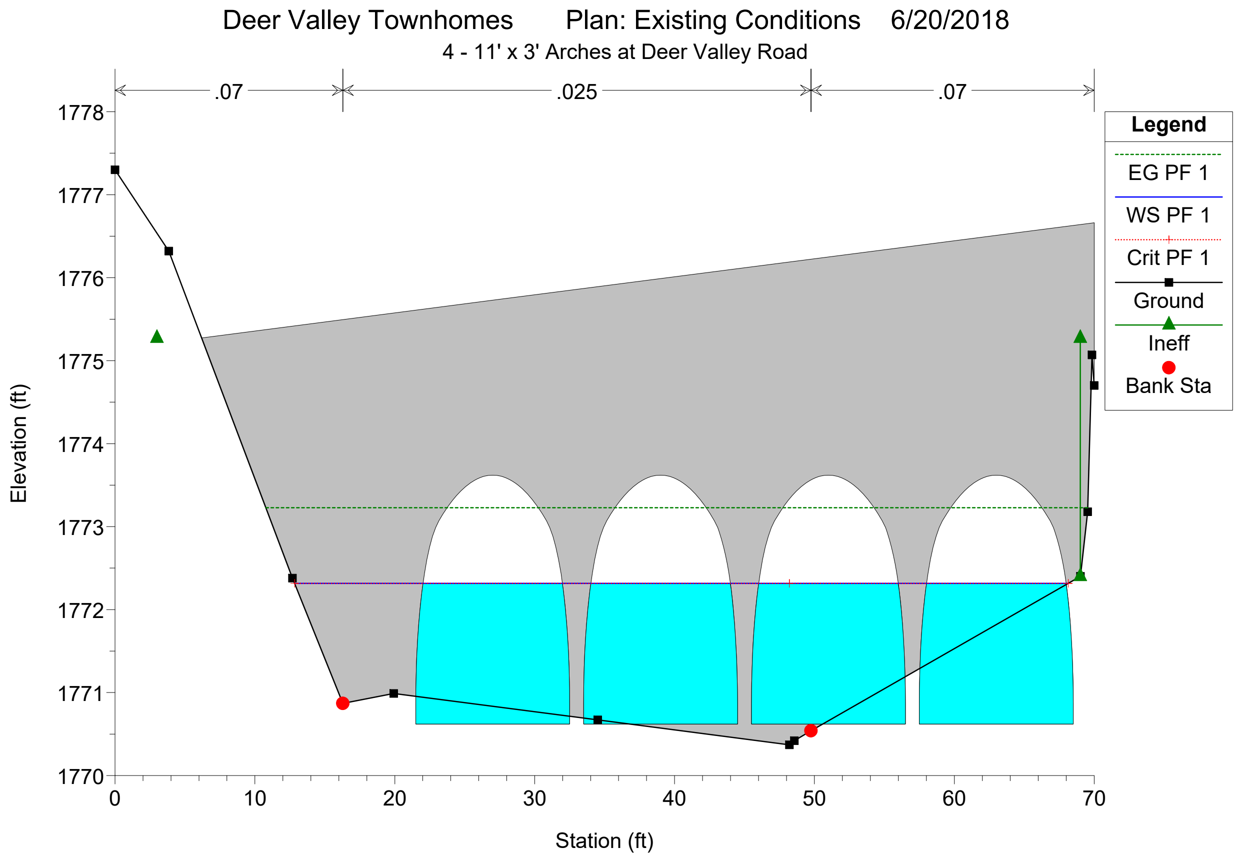

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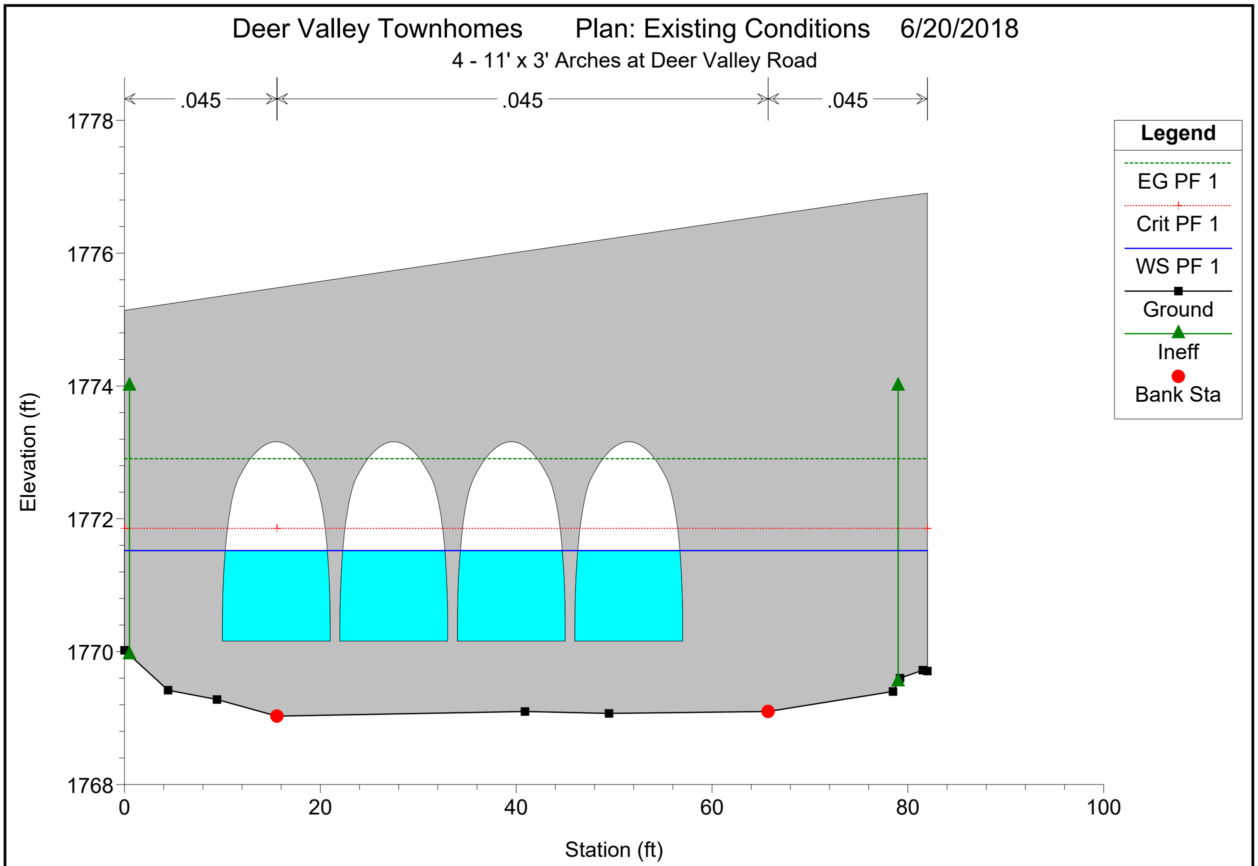

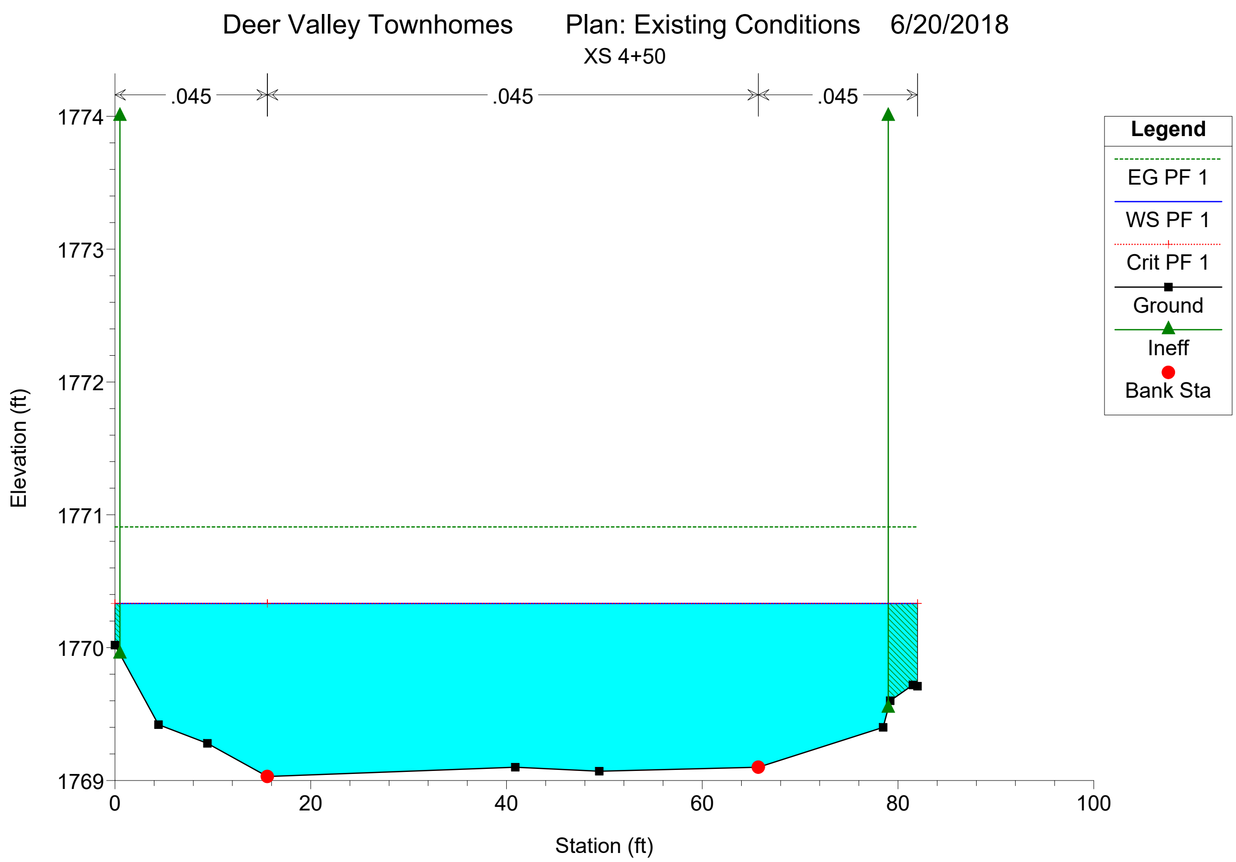

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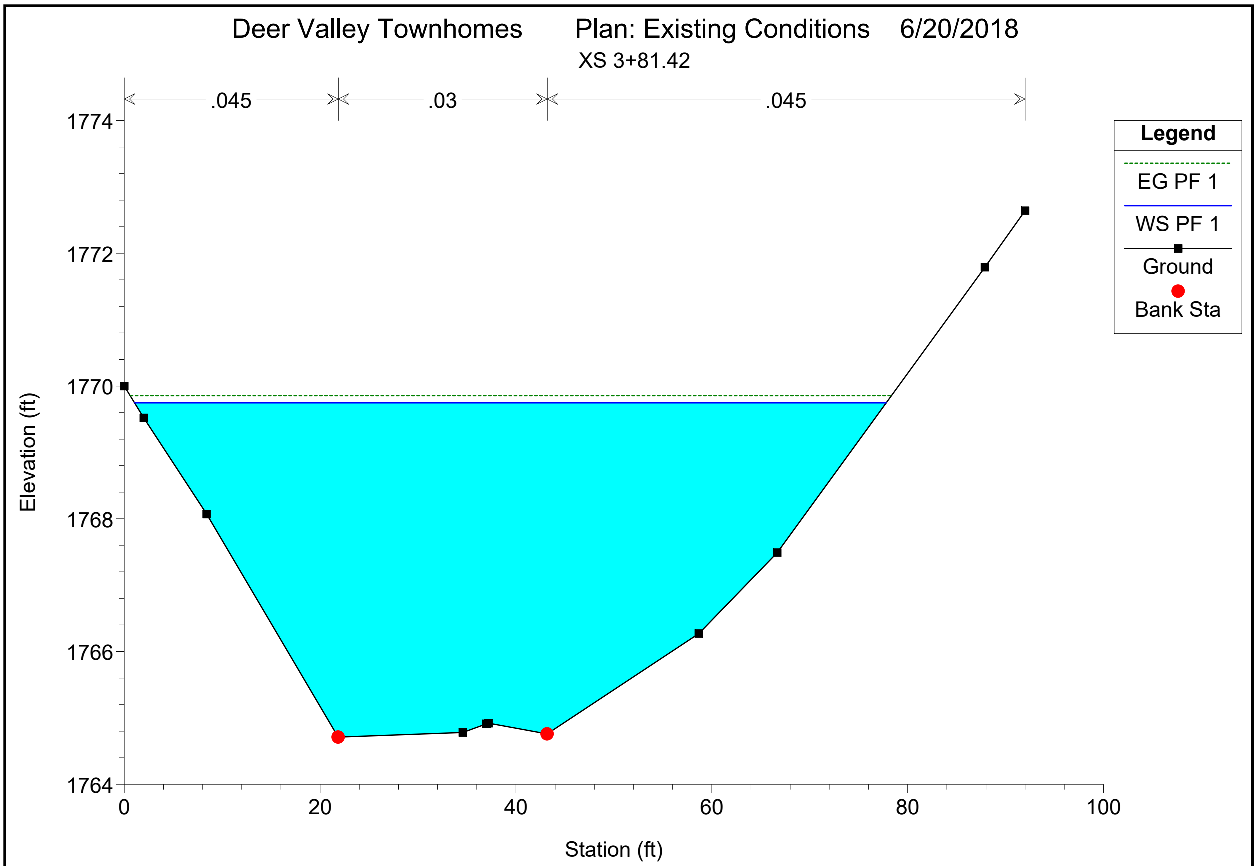

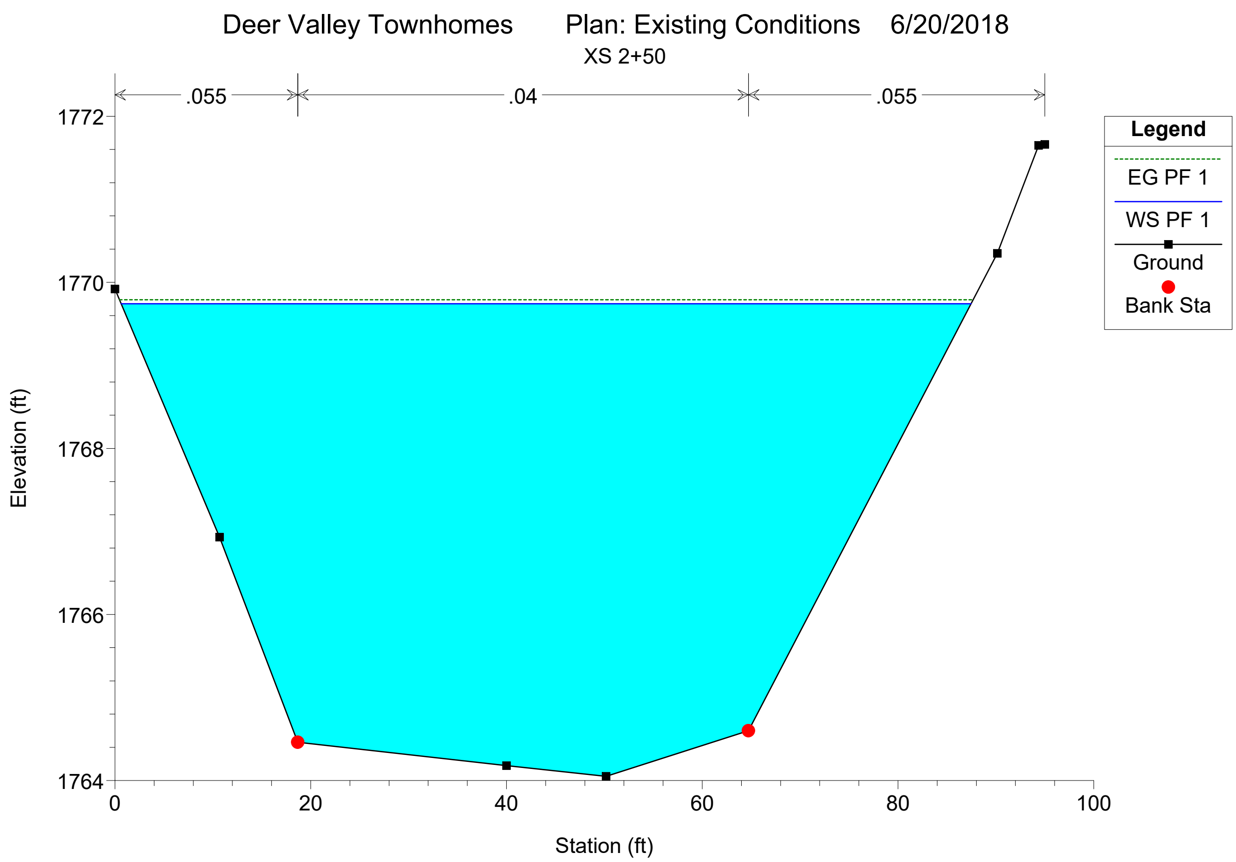

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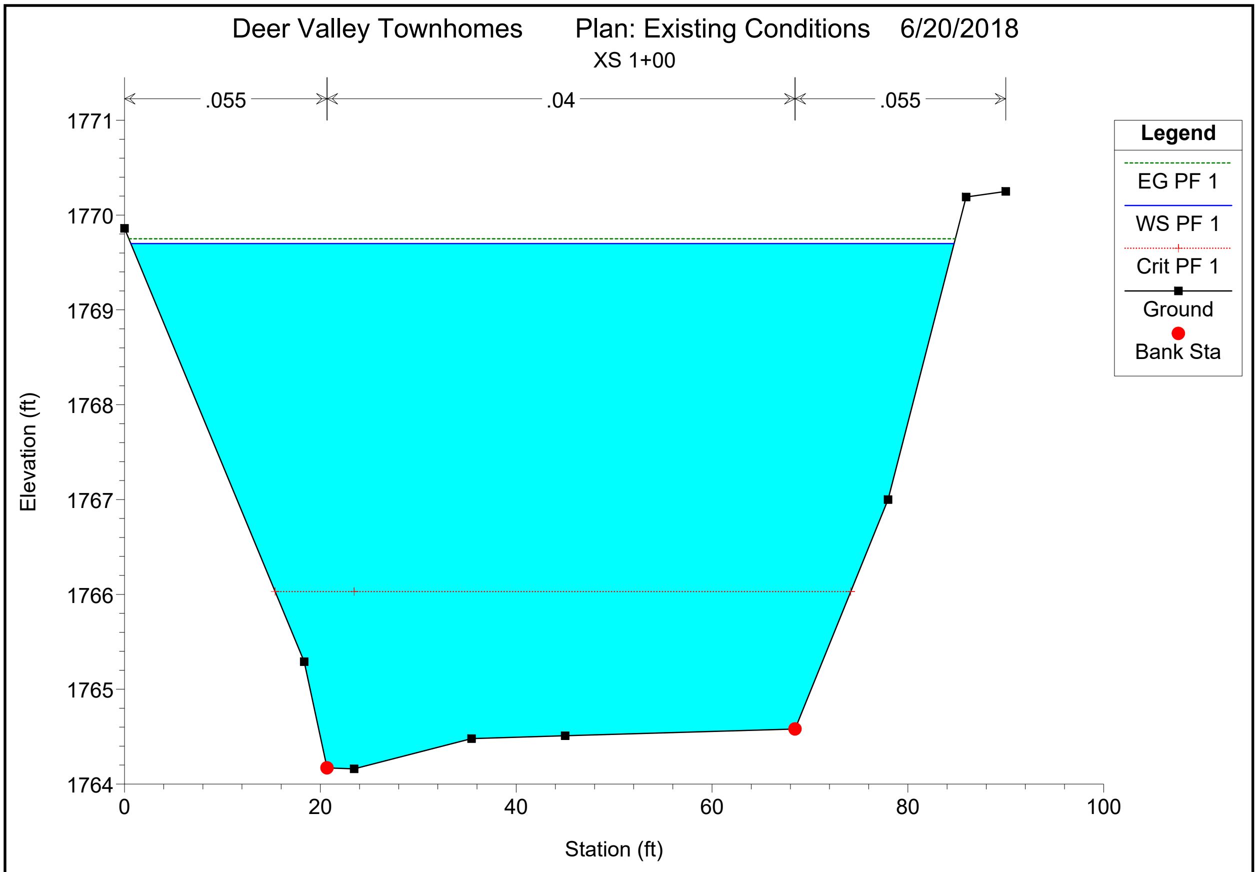

43-DR-2019
03/17/20

HEC-RAS Plan: EX COND River: Existing Reach: RAS River Sta Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
RAS River Sta	950	PF 1	557.00	1778.06	1781.95	1781.95	1783.76	0.006950	12.20	83.71	34.73	1.09
RAS River Sta	850	PF 1	557.00	1776.14	1780.11	1780.11	1781.77	0.006141	11.42	82.10	33.14	1.03
RAS River Sta	794	PF 1	557.00	1774.76	1777.57	1777.57	1778.83	0.006384	9.32	74.73	34.23	0.99
RAS River Sta	757		Culvert									
RAS River Sta	723	PF 1	557.00	1773.16	1777.87	1775.82	1778.17	0.000801	4.66	171.75	49.51	0.38
RAS River Sta	660	PF 1	557.00	1772.02	1776.08	1776.08	1777.67	0.006634	11.94	95.62	40.98	1.07
RAS River Sta	600	PF 1	557.00	1771.11	1774.18	1774.18	1775.37	0.006423	9.26	83.85	41.91	0.99
RAS River Sta	558	PF 1	557.00	1770.37	1773.19	1772.66	1773.68	0.002940	5.93	123.01	58.66	0.66
RAS River Sta	505		Culvert									
RAS River Sta	450	PF 1	557.00	1769.03	1770.33	1770.33	1770.91	0.026927	6.31	92.00	82.00	0.99
RAS River Sta	381.42	PF 1	557.00	1764.71	1769.75		1769.86	0.000495	3.20	258.18	76.76	0.25
RAS River Sta	250	PF 1	557.00	1764.05	1769.74		1769.79	0.000265	1.88	356.65	86.83	0.14
RAS River Sta	100	PF 1	557.00	1764.16	1769.70	1766.03	1769.75	0.000285	1.89	347.50	84.08	0.15

Plan: EX COND Existing RAS River Sta RS: 950 Profile: PF 1

E.G. Elev (ft)	1783.76	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.80	Wt. n-Val.	0.070	0.025	0.070
W.S. Elev (ft)	1781.95	Reach Len. (ft)	100.00	100.00	100.00
Crit W.S. (ft)	1781.95	Flow Area (sq ft)	25.70	35.18	22.83
E.G. Slope (ft/ft)	0.006950	Area (sq ft)	25.70	35.18	22.83
Q Total (cfs)	557.00	Flow (cfs)	68.92	429.12	58.96
Top Width (ft)	34.73	Top Width (ft)	13.21	9.11	12.41
Vel Total (ft/s)	6.65	Avg. Vel. (ft/s)	2.68	12.20	2.58
Max Chl Dpth (ft)	3.89	Hydr. Depth (ft)	1.95	3.86	1.84
Conv. Total (cfs)	6681.5	Conv. (cfs)	826.7	5147.5	707.2
Length Wtd. (ft)	100.00	Wetted Per. (ft)	13.77	9.11	12.98
Min Ch El (ft)	1778.06	Shear (lb/sq ft)	0.81	1.68	0.76
Alpha	2.62	Stream Power (lb/ft s)	2.17	20.44	1.97
Frctn Loss (ft)	0.65	Cum Volume (acre-ft)	0.52	2.05	0.69
C & E Loss (ft)	0.04	Cum SA (acres)	0.28	0.57	0.35

Plan: EX COND Existing RAS River Sta RS: 850 Profile: PF 1

E.G. Elev (ft)	1781.77	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.67	Wt. n-Val.	0.070	0.025	0.070
W.S. Elev (ft)	1780.11	Reach Len. (ft)	56.00	56.00	56.00
Crit W.S. (ft)	1780.11	Flow Area (sq ft)	17.87	39.78	24.45
E.G. Slope (ft/ft)	0.006141	Area (sq ft)	17.87	39.78	24.45
Q Total (cfs)	557.00	Flow (cfs)	41.68	454.08	61.24
Top Width (ft)	33.14	Top Width (ft)	10.15	10.35	12.63
Vel Total (ft/s)	6.78	Avg. Vel. (ft/s)	2.33	11.42	2.50
Max Chl Dpth (ft)	3.97	Hydr. Depth (ft)	1.76	3.84	1.94
Conv. Total (cfs)	7108.0	Conv. (cfs)	531.9	5794.6	781.5
Length Wtd. (ft)	56.00	Wetted Per. (ft)	10.76	10.37	13.24
Min Ch El (ft)	1776.14	Shear (lb/sq ft)	0.64	1.47	0.71
Alpha	2.33	Stream Power (lb/ft s)	1.49	16.79	1.77
Frctn Loss (ft)	0.35	Cum Volume (acre-ft)	0.47	1.97	0.64
C & E Loss (ft)	0.12	Cum SA (acres)	0.25	0.55	0.32

Plan: EX COND Existing RAS River Sta RS: 794 Profile: PF 1

E.G. Elev (ft)	1778.83	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.26	Wt. n-Val.	0.070	0.025	0.070
W.S. Elev (ft)	1777.57	Reach Len. (ft)	71.00	71.00	71.00
Crit W.S. (ft)	1777.57	Flow Area (sq ft)	10.07	55.69	8.97
E.G. Slope (ft/ft)	0.006384	Area (sq ft)	10.07	55.69	8.97
Q Total (cfs)	557.00	Flow (cfs)	20.86	519.13	17.01
Top Width (ft)	34.23	Top Width (ft)	6.96	20.25	7.02
Vel Total (ft/s)	7.45	Avg. Vel. (ft/s)	2.07	9.32	1.90
Max Chl Dpth (ft)	2.81	Hydr. Depth (ft)	1.45	2.75	1.28
Conv. Total (cfs)	6971.1	Conv. (cfs)	261.0	6497.2	212.9
Length Wtd. (ft)	71.00	Wetted Per. (ft)	7.47	20.25	7.59
Min Ch El (ft)	1774.76	Shear (lb/sq ft)	0.54	1.10	0.47
Alpha	1.46	Stream Power (lb/ft s)	1.11	10.22	0.89
Frctn Loss (ft)		Cum Volume (acre-ft)	0.46	1.91	0.62
C & E Loss (ft)		Cum SA (acres)	0.24	0.53	0.31

Plan: EX COND Existing RAS River Sta RS: 723 Profile: PF 1

E.G. Elev (ft)	1778.17	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.30	Wt. n-Val.	0.070	0.025	0.070
W.S. Elev (ft)	1777.87	Reach Len. (ft)	63.00	63.00	63.00
Crit W.S. (ft)	1775.82	Flow Area (sq ft)	28.70	104.47	38.58
E.G. Slope (ft/ft)	0.000801	Area (sq ft)	28.70	104.47	38.58
Q Total (cfs)	557.00	Flow (cfs)	28.89	486.32	41.80
Top Width (ft)	49.51	Top Width (ft)	12.40	22.68	14.43
Vel Total (ft/s)	3.24	Avg. Vel. (ft/s)	1.01	4.66	1.08
Max Chl Dpth (ft)	4.71	Hydr. Depth (ft)	2.32	4.61	2.67
Conv. Total (cfs)	19681.9	Conv. (cfs)	1020.7	17184.2	1476.9
Length Wtd. (ft)	63.00	Wetted Per. (ft)	13.23	22.69	15.93
Min Ch El (ft)	1773.16	Shear (lb/sq ft)	0.11	0.23	0.12
Alpha	1.81	Stream Power (lb/ft s)	0.11	1.07	0.13
Frctn Loss (ft)	0.11	Cum Volume (acre-ft)	0.46	1.85	0.62
C & E Loss (ft)	0.39	Cum SA (acres)	0.23	0.49	0.29

Plan: EX COND Existing RAS River Sta RS: 660 Profile: PF 1

E.G. Elev (ft)	1777.67	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.59	Wt. n-Val.	0.070	0.025	0.070
W.S. Elev (ft)	1776.08	Reach Len. (ft)	60.00	60.00	60.00
Crit W.S. (ft)	1776.08	Flow Area (sq ft)	30.73	32.77	32.12
E.G. Slope (ft/ft)	0.006634	Area (sq ft)	30.73	32.77	32.12
Q Total (cfs)	557.00	Flow (cfs)	83.21	391.42	82.37
Top Width (ft)	40.98	Top Width (ft)	15.14	8.45	17.39
Vel Total (ft/s)	5.83	Avg. Vel. (ft/s)	2.71	11.94	2.56
Max Chl Dpth (ft)	4.06	Hydr. Depth (ft)	2.03	3.88	1.85
Conv. Total (cfs)	6838.4	Conv. (cfs)	1021.5	4805.5	1011.3
Length Wtd. (ft)	60.00	Wetted Per. (ft)	15.68	8.46	17.78
Min Ch El (ft)	1772.02	Shear (lb/sq ft)	0.81	1.60	0.75
Alpha	3.01	Stream Power (lb/ft s)	2.20	19.17	1.92
Frctn Loss (ft)	0.39	Cum Volume (acre-ft)	0.41	1.75	0.57
C & E Loss (ft)	0.12	Cum SA (acres)	0.21	0.47	0.27

Plan: EX COND Existing RAS River Sta RS: 600 Profile: PF 1

E.G. Elev (ft)	1775.37	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.19	Wt. n-Val.	0.070	0.025	0.070
W.S. Elev (ft)	1774.18	Reach Len. (ft)	42.00	42.00	42.00
Crit W.S. (ft)	1774.18	Flow Area (sq ft)	18.62	53.27	11.96
E.G. Slope (ft/ft)	0.006423	Area (sq ft)	18.62	53.27	11.96
Q Total (cfs)	557.00	Flow (cfs)	41.32	493.39	22.29
Top Width (ft)	41.91	Top Width (ft)	12.12	19.63	10.17
Vel Total (ft/s)	6.64	Avg. Vel. (ft/s)	2.22	9.26	1.86
Max Chl Dpth (ft)	3.07	Hydr. Depth (ft)	1.54	2.71	1.18
Conv. Total (cfs)	6950.0	Conv. (cfs)	515.5	6156.4	278.1
Length Wtd. (ft)	42.00	Wetted Per. (ft)	12.50	19.64	10.43
Min Ch El (ft)	1771.11	Shear (lb/sq ft)	0.60	1.09	0.46
Alpha	1.73	Stream Power (lb/ft s)	1.33	10.07	0.86
Frctn Loss (ft)	0.18	Cum Volume (acre-ft)	0.38	1.69	0.54
C & E Loss (ft)	0.21	Cum SA (acres)	0.19	0.45	0.25

Plan: EX COND Existing RAS River Sta RS: 558 Profile: PF 1

E.G. Elev (ft)	1773.68	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.49	Wt. n-Val.	0.070	0.025	0.070
W.S. Elev (ft)	1773.19	Reach Len. (ft)	108.00	108.00	108.00
Crit W.S. (ft)	1772.66	Flow Area (sq ft)	6.38	83.47	33.16
E.G. Slope (ft/ft)	0.002940	Area (sq ft)	6.38	83.47	33.38
Q Total (cfs)	557.00	Flow (cfs)	7.74	494.60	54.67
Top Width (ft)	58.66	Top Width (ft)	5.42	33.46	19.78
Vel Total (ft/s)	4.53	Avg. Vel. (ft/s)	1.21	5.93	1.65
Max Chl Dpth (ft)	2.82	Hydr. Depth (ft)	1.18	2.49	1.72
Conv. Total (cfs)	10273.0	Conv. (cfs)	142.7	9122.1	1008.3
Length Wtd. (ft)	108.00	Wetted Per. (ft)	5.90	33.48	19.34
Min Ch El (ft)	1770.37	Shear (lb/sq ft)	0.20	0.46	0.31
Alpha	1.53	Stream Power (lb/ft s)	0.24	2.71	0.52
Frctn Loss (ft)		Cum Volume (acre-ft)	0.37	1.62	0.51
C & E Loss (ft)		Cum SA (acres)	0.18	0.42	0.24

Plan: EX COND Existing RAS River Sta RS: 450 Profile: PF 1

E.G. Elev (ft)	1770.91	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.58	Wt. n-Val.	0.045	0.045	0.045
W.S. Elev (ft)	1770.33	Reach Len. (ft)	68.58	68.58	68.58
Crit W.S. (ft)	1770.33	Flow Area (sq ft)	14.67	63.09	14.24
E.G. Slope (ft/ft)	0.026927	Area (sq ft)	14.84	63.09	16.25
Q Total (cfs)	557.00	Flow (cfs)	77.94	398.27	80.79
Top Width (ft)	82.00	Top Width (ft)	15.57	50.17	16.26
Vel Total (ft/s)	6.05	Avg. Vel. (ft/s)	5.31	6.31	5.67
Max Chl Dpth (ft)	1.30	Hydr. Depth (ft)	0.97	1.26	1.07
Conv. Total (cfs)	3394.4	Conv. (cfs)	475.0	2427.1	492.4
Length Wtd. (ft)	68.58	Wetted Per. (ft)	15.11	50.17	13.28
Min Ch El (ft)	1769.03	Shear (lb/sq ft)	1.63	2.11	1.80
Alpha	1.01	Stream Power (lb/ft s)	8.67	13.34	10.22
Frctn Loss (ft)	0.11	Cum Volume (acre-ft)	0.37	1.54	0.51
C & E Loss (ft)	0.02	Cum SA (acres)	0.15	0.32	0.19

Plan: EX COND Existing RAS River Sta RS: 381.42 Profile: PF 1

E.G. Elev (ft)	1769.86	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.11	Wt. n-Val.	0.045	0.030	0.045
W.S. Elev (ft)	1769.75	Reach Len. (ft)	131.42	131.42	131.42
Crit W.S. (ft)		Flow Area (sq ft)	51.28	105.87	101.04
E.G. Slope (ft/ft)	0.000495	Area (sq ft)	51.28	105.87	101.04
Q Total (cfs)	557.00	Flow (cfs)	67.45	339.17	150.38
Top Width (ft)	76.76	Top Width (ft)	20.79	21.34	34.63
Vel Total (ft/s)	2.16	Avg. Vel. (ft/s)	1.32	3.20	1.49
Max Chl Dpth (ft)	5.04	Hydr. Depth (ft)	2.47	4.96	2.92
Conv. Total (cfs)	25044.7	Conv. (cfs)	3032.6	15250.4	6761.7
Length Wtd. (ft)	131.42	Wetted Per. (ft)	21.39	21.35	35.02
Min Ch El (ft)	1764.71	Shear (lb/sq ft)	0.07	0.15	0.09
Alpha	1.52	Stream Power (lb/ft s)	0.10	0.49	0.13
Frctn Loss (ft)	0.05	Cum Volume (acre-ft)	0.31	1.40	0.42
C & E Loss (ft)	0.02	Cum SA (acres)	0.12	0.26	0.15

Plan: EX COND Existing RAS River Sta RS: 250 Profile: PF 1

E.G. Elev (ft)	1769.79	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.05	Wt. n-Val.	0.055	0.040	0.055
W.S. Elev (ft)	1769.74	Reach Len. (ft)	150.00	150.00	150.00
Crit W.S. (ft)		Flow Area (sq ft)	46.48	251.72	58.45
E.G. Slope (ft/ft)	0.000265	Area (sq ft)	46.48	251.72	58.45
Q Total (cfs)	557.00	Flow (cfs)	37.36	472.19	47.45
Top Width (ft)	86.83	Top Width (ft)	18.04	46.05	22.73
Vel Total (ft/s)	1.56	Avg. Vel. (ft/s)	0.80	1.88	0.81
Max Chl Dpth (ft)	5.69	Hydr. Depth (ft)	2.58	5.47	2.57
Conv. Total (cfs)	34220.9	Conv. (cfs)	2295.5	29010.3	2915.1
Length Wtd. (ft)	150.00	Wetted Per. (ft)	18.80	46.06	23.31
Min Ch El (ft)	1764.05	Shear (lb/sq ft)	0.04	0.09	0.04
Alpha	1.26	Stream Power (lb/ft s)	0.03	0.17	0.03
Frctn Loss (ft)	0.04	Cum Volume (acre-ft)	0.17	0.86	0.18
C & E Loss (ft)	0.00	Cum SA (acres)	0.07	0.16	0.07

Plan: EX COND Existing RAS River Sta RS: 100 Profile: PF 1

E.G. Elev (ft)	1769.75	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.05	Wt. n-Val.	0.055	0.040	0.055
W.S. Elev (ft)	1769.70	Reach Len. (ft)			
Crit W.S. (ft)	1766.03	Flow Area (sq ft)	50.67	250.58	46.25
E.G. Slope (ft/ft)	0.000285	Area (sq ft)	50.67	250.58	46.25
Q Total (cfs)	557.00	Flow (cfs)	41.79	474.22	41.00
Top Width (ft)	84.08	Top Width (ft)	20.05	47.79	16.25
Vel Total (ft/s)	1.60	Avg. Vel. (ft/s)	0.82	1.89	0.89
Max Chl Dpth (ft)	5.54	Hydr. Depth (ft)	2.53	5.24	2.85
Conv. Total (cfs)	32996.4	Conv. (cfs)	2475.3	28092.5	2428.6
Length Wtd. (ft)		Wetted Per. (ft)	20.84	47.79	17.07
Min Ch El (ft)	1764.16	Shear (lb/sq ft)	0.04	0.09	0.05
Alpha	1.23	Stream Power (lb/ft s)	0.04	0.18	0.04
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

Plan: EX COND Existing RAS River Sta RS: 757 Culv Group: Culvert #1 Profile: PF 1

Q Culv Group (cfs)	557.00	Culv Full Len (ft)	
# Barrels	4	Culv Vel US (ft/s)	6.32
Q Barrel (cfs)	139.25	Culv Vel DS (ft/s)	5.70
E.G. US. (ft)	1778.80	Culv Inv El Up (ft)	1774.69
W.S. US. (ft)	1777.57	Culv Inv El Dn (ft)	1774.29
E.G. DS (ft)	1778.17	Culv Frctn Ls (ft)	0.11
W.S. DS (ft)	1777.87	Culv Exit Loss (ft)	0.21
Delta EG (ft)	0.63	Culv Entr Loss (ft)	0.31
Delta WS (ft)	0.31	Q Weir (cfs)	
E.G. IC (ft)	1778.56	Weir Sta Lft (ft)	
E.G. OC (ft)	1778.80	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	1777.87	Weir Max Depth (ft)	
Culv WS Outlet (ft)	1777.87	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	2.18	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	2.31	Min El Weir Flow (ft)	1779.72

Plan: EX COND Existing RAS River Sta RS: 505 Culv Group: Culvert #1 Profile: PF 1

Q Culv Group (cfs)	557.00	Culv Full Len (ft)	
# Barrels	4	Culv Vel US (ft/s)	7.66
Q Barrel (cfs)	139.25	Culv Vel DS (ft/s)	9.43
E.G. US. (ft)	1773.68	Culv Inv El Up (ft)	1770.62
W.S. US. (ft)	1773.19	Culv Inv El Dn (ft)	1770.16
E.G. DS (ft)	1770.91	Culv Frctn Ls (ft)	0.32
W.S. DS (ft)	1770.33	Culv Exit Loss (ft)	2.00
Delta EG (ft)	2.78	Culv Entr Loss (ft)	0.46
Delta WS (ft)	2.86	Q Weir (cfs)	
E.G. IC (ft)	1773.39	Weir Sta Lft (ft)	
E.G. OC (ft)	1773.68	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	1772.32	Weir Max Depth (ft)	
Culv WS Outlet (ft)	1771.52	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	1.27	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	1.70	Min El Weir Flow (ft)	1775.28

LISTEN | DESIGN
PLAN | BUILD

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